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U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,

A. C. TRUE, Director.

Irrigation Investigations, Elwood Mead, Expert in Charge.

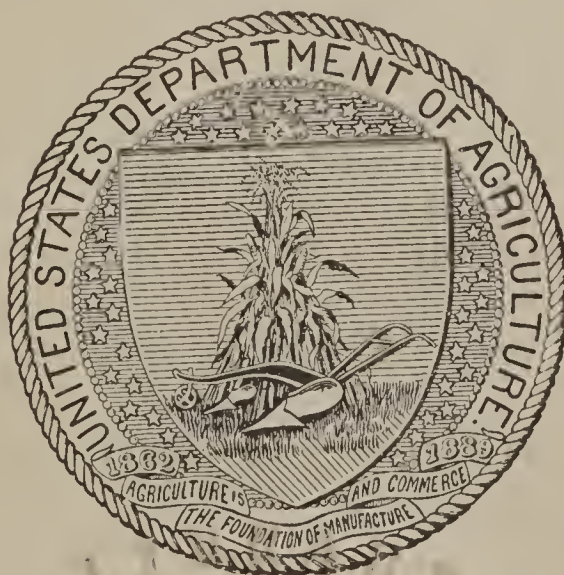
IRRIGATION INVESTIGATIONS IN CALIFORNIA.

UNDER THE DIRECTION OF

ELWOOD MEAD,

*Expert in Charge of Irrigation Investigations of the Office of Experiment
Stations, U. S. Department of Agriculture,*

ASSISTED BY

WILLIAM E. SMYTHE, MARSDEN MANSON, J. M. WILSON, CHARLES D. MARX, FRANK SOULÉ,
C. E. GRUNSKY, EDWARD M. BOGGS, and JAMES D. SCHUYLER.JANUARY 24, 1901.—Referred to the Committee on Irrigation and
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1901.

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U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., January 22, 1901.

SIR: I have the honor to transmit herewith a summary report on the irrigation investigations made by this Department in the State of California during the past year, in response to the following Senate resolution passed January 14, 1901:

Resolved, That the Secretary of Agriculture be, and hereby is, directed to transmit to the Senate the results of the cooperative irrigation investigations made in the State of California by the Department of Agriculture and the California Water and Forest Association.

Very respectfully,

JAMES WILSON,
Secretary.

The PRESIDENT OF THE SENATE.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., January 22, 1901.

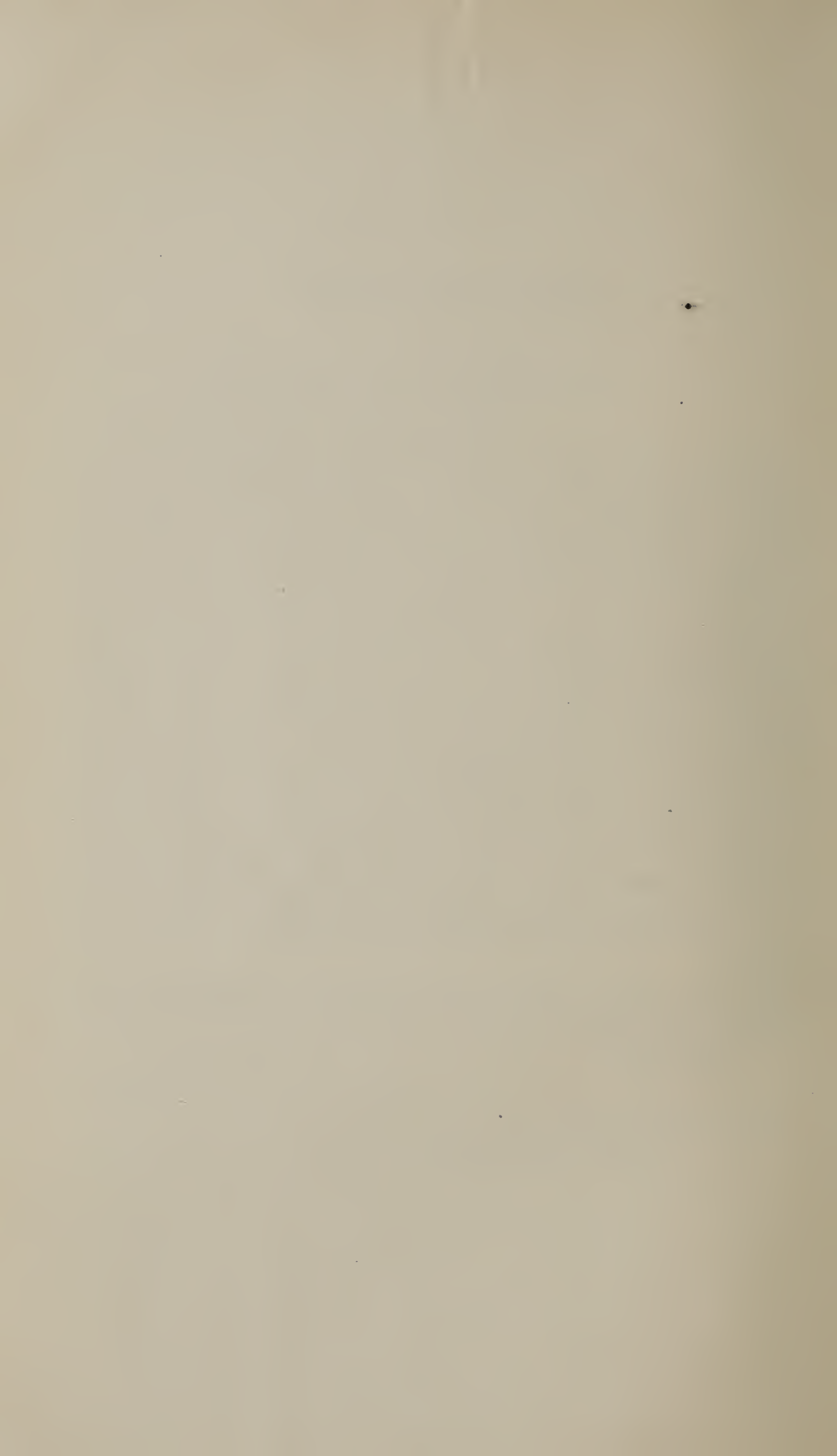
SIR: I have the honor to transmit herewith a preliminary report on irrigation investigations conducted in California during 1900 by the Office of Experiment Stations in cooperation with the California Water and Forest Association. This report has been prepared in accordance with your instructions as a response to the Senate resolution of January 14, 1901. It includes a brief statement of the plan, organization, and outcome of the investigation and shows the contents of the complete report now in course of preparation, which, it is estimated, will make a bulletin of some 400 quarto pages. Extracts from the reports of the agents and experts having charge of the work in different localities in California are also given. These extracts have been selected to show the location and character of the districts studied and to indicate the spirit and methods of the inquiry. The general conclusions agreed to by all of the agents and experts, with the views set forth in the extracts from their separate reports, will, it is believed, indicate the nature of the reforms required to put irrigated agriculture in California on a more enduring and satisfactory basis, and thus to promote the more rapid and successful development of the State's resources.

The work on the complete report on these investigations is well advanced and I hope to submit it for publication at an early date.

Respectfully,

A. C. TRUE,
Director.

Hon. JAMES WILSON,
Secretary of Agriculture.



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IRRIGATION INVESTIGATIONS IN CALIFORNIA.

INTRODUCTION.

In accordance with the terms of the act making appropriations for irrigation investigations by the Office of Experiment Stations of the United States Department of Agriculture, two general lines of investigations have been pursued: (1) The study of the laws and institutions relating to irrigation in different regions, and (2) the determination of the actual use made of irrigation waters. As the main object of studying the irrigation laws and institutions of the arid region is to bring out the ways in which existing conditions which are unsatisfactory may be improved, it has been found that this line of investigations should be immediately connected with the investigations regarding the use of water. It has also been found more satisfactory to make as thorough an investigation as practicable of particular regions rather than to scatter our studies over wide areas. For these reasons the two lines of work are being carried on together in a number of places.

The largest single enterprise connected with the irrigation investigations in which the Office is at present engaged is in the State of California. The growing value and increasing scarcity of water are creating an imperative need for better laws to control the distribution of streams in that State, and there is much public interest in this subject.

ORIGIN OF THE INVESTIGATIONS IN CALIFORNIA.

These investigations had their inception in July, 1899, during a visit of the Director of the Office of Experiment Stations of the United States Department of Agriculture to California, where he was waited upon by a committee of the citizens of San Francisco, who requested the Office to undertake a comprehensive study of the legal and economic problems created by irrigation development in California. Later on the following petition dealing with the same matter was presented:

To Dr. A. C. TRUE,

Director United States Agricultural Experiment Stations:

The undersigned earnestly desire that Mr. Elwood Mead be detailed by the Department to conduct a series of irrigation investigations in California, and trust that you may feel justified in forwarding this request to the honorable Secretary of Agriculture

with your approval. We have, of course, ascertained that the proposed detail will not be contrary to Mr. Mead's inclination or his judgment.

We respectfully submit that nowhere in America are there irrigation problems more important, more intricate, or more pressing than in California. Neither are there any whose study would be more greatly instructive. We can offer, we presume, examples of every form of evil which can be found in Anglo-Saxon dealings with water in arid and semiarid districts. Great sums have been lost in irrigation enterprises. Still greater sums are endangered. Water titles are uncertain. The litigation is appalling.

Among the things necessary to be known before we can hope for well-considered legislation upon the conservation and distribution of our waters are the following:

First. The amount of water in the streams.

Second. The duty of water in the different irrigation basins.

Third. The claims upon the water, collated by streams and not by counties as now.

Fourth. The nature of water-right titles.

Fifth. The adjudicated claims upon the waters.

Sixth. The lands now irrigated and susceptible of irrigation.

Seventh. The possible increase of water for beneficial use by storage in each system.

Eighth. The extent to which the irrigable area can be increased by better methods of distribution and use.

This petition was signed by E. J. Wickson, acting director University of California Experiment Station; J. A. Filcher, manager State board of trade; William Thomas; David Starr Jordan, president Leland Stanford Junior University; E. B. Pond, president San Francisco Savings Union; William Alvord, president Bank of California; Charles H. Gilbert, vice-president California Academy of Sciences; Marsden Manson; T. A. Kirkpatrick, vice-president P. C. M. M. D. Company; E. E. Patten; Grant S. Taggart; Frank Soulé, professor of civil engineering, University of California; Julius Kahn; Victor H. Metcalf; German Savings and Loan Society, by B. A. Becker, president; E. J. LeBreton, president French Savings Bank of San Francisco; California Safe Deposit and Trust Company; W. E. Brown, vice-president Crocker-Woolworth National Bank; Hibernia Savings and Loan Society, by Robert J. Tobin, secretary; M. H. DeYoung, San Francisco Chronicle; J. M. Gleaves, president California Water and Forest Society; David M. DeLong, manager Nevada and Monetta placer mines; R. H. Goodwin, United States deputy mineralogical surveyor; Frank W. Smith; Ernst A. Denicke, president Germania Trust Company; C. E. Grunsky, civil engineer; George C. Perkins; Andrew W. Kiddie, United States deputy mineralogical surveyor.

A convention of irrigators was held in San Francisco in November, 1899. At this convention another request for this investigation was incorporated in the resolutions adopted and the California Water and Forest Association, which grew out of this convention, offered to extend financial aid in the prosecution of these studies, and has provided \$4,875 to be expended in such investigations, in accordance with a plan prepared by Mr. Mead, expert in charge, the outlines of which are indicated by the following letter of instructions issued to the experts in charge of the work:

INSTRUCTIONS TO SPECIAL AGENTS AND EXPERTS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE IN THE INVESTIGATIONS RELATING TO IRRIGATION IN CALIFORNIA.

GENTLEMEN: The study of the irrigation laws, customs, and conditions of California, in which your services have been secured, is the most comprehensive investigation of these questions yet undertaken in this country. This gives to the facts you are to gather and the reports and conclusions based thereon an exceptional interest.

What you will do in California is being done in other States, and for the purpose of comparing results it is desirable, as far as may be, that all these investigations shall pursue the same general plan, discuss the same general problems, and follow the same order in their treatment. Because of this and because each of you will act independently in the collection of data and in formulating your conclusions, it is necessary that there be a preliminary understanding regarding both the nature of the subjects to be dealt with and the general form of your reports thereon. As an aid to such understanding and concert of action, the following suggestions are submitted:

PLAN OF WORK.

On the stream and its tributaries embraced in your field of investigation endeavor to secure all of the facts showing the operation of the present irrigation system. This to include:

First. Abstracts of the records of claims to water; character of those records, including the number of claims, total volume claimed, place where recorded, and the ease or difficulty with which the validity of any claim can be determined.

Second. Rights to water for other purposes than irrigation, viz: Mining power and domestic use.

Third. The methods by which the amount and character of water rights are determined, accessibility, and completeness of the record showing the nature of the established rights.

Fourth. Character of litigation over water rights, its cost, the causes therefor, its influence on irrigation development, and the principles established by decisions rendered in cases arising on the stream being studied.

Fifth. Rights for storage and underground waters, how acquired and how they are affected by rights to the surface flow of streams, and how the use of underground waters influence the streams' discharge.

Sixth. Nature of an appropriation of water. Who is regarded as the appropriator, the ditch builder, the owner of the land on which water is used, or is the land itself the appropriator? What is the measure of its amount, the size of the claim, the capacity of the ditch, or the area irrigated?

FIELD INVESTIGATIONS.

Seventh. Collection of data showing discharge of stream, or measurement of its discharge where no such data can be had, study of volume of return or seepage water and its availability for being again diverted, and its influence on the value of irrigators' rights.

Eighth. Size, number, location, and capacity of ditches and other distributing works established, and the duty of water obtained.

Ninth. Collection of data showing how water is divided among different ditches from the same stream, how it is distributed among users. Nature of water-right contracts between canal owners and water users, including facts showing what contracts have proven satisfactory and what ones have given rise to controversy, with the reason therefor. Collection of information showing the value of water for irrigation as shown by the rates paid for its delivery, the methods by which these rates are established, and their justice or objectionable features.

REPORTS.

Tenth. While the facts gathered will largely modify the nature of their presentation, which will vary somewhat in each instance, it will greatly aid those who read these reports and especially your conclusions if the latter deal with the same issues and in the same order. The following scheme is suggested:

(a) The foundation of any system of administrative laws is the method of establishing rights to the stream. In your discussion of the results in California, the first question to be considered is whether or not the present method of filing and recording claims to water is satisfactory. If not, what should take its place?

(b) Is the present method of adjudicating rights satisfactory? If not, what should replace it?

(c) The present law provides for the appropriation of water for sale, rental, or distribution. Does it provide for its direct appropriation by the user without the intervention of the seller, renter, or distributor? Is there any method by which the owner of a tract of land can acquire directly from the public a right to the water which reclaims that land, as he can now obtain title to the public land itself by means of the desert or homestead laws? If not, should there be legislation to provide for this?

(d) Is the present system of stream control or lack of it and the dividing of water between the different ditches which divert the common supply satisfactory? If not, what form of administration or control should take its place?

(e) Should there be a State engineer, and if so, what should be his duties?

(f) Should there be a central office of record of claims or titles to water in place of the present separate county records, and what supervision or control should be exercised over rights to be acquired hereafter?

(g) What steps should be taken to secure the fullest conservation and use of water which now runs to waste? The discussion of this question is to include State or national control and aid, the legislation needed to define rights to stored water, and to determine who is entitled to the water thus stored.

It is understood that this outline will not touch all of the complex and important problems which your investigations will disclose and with which your reports will have to deal. It is, however, believed to state some of the leading ones with which legislators and users of water are now confronted, not only in California, but in every other Commonwealth.

Sincerely yours,

ELWOOD MEAD,
Irrigation Expert in Charge.

AGREEMENT WITH CALIFORNIA WATER AND FOREST ASSOCIATION.

The agreement with this association is shown in the following memorandum, approved May 22, 1900:

Memorandum of agreement between the irrigation investigations of the Office of Experiment Stations, United States Department of Agriculture, and the California Water and Forest Association.

The parties hereto agree to cooperate in the performance of the work specified in the circular letter of the expert in charge of irrigation investigations to its special agents relative to the investigation of the water supply, water rights, duty of water, etc., on the various rivers of the State of California north of the Tehachapi Pass. For the purpose of this cooperation the parties hereto will contribute to the expense thereof as follows:

On the Kings River the said irrigation investigations will contribute the sum of three hundred and seventy-five dollars (\$375) and the California Water and Forest Association will contribute the sum of eleven hundred and twenty-five dollars (\$1,125).

On the San Joaquin River the said irrigation investigations will contribute the sum of three hundred and seventy-five dollars (\$375) and the said association will contribute the sum of eleven hundred and twenty-five dollars (\$1,125).

On the Salinas River the said irrigation investigations and the said association will each contribute the sum of three hundred and seventy-five dollars (\$375).

On the Yuba River the said irrigation investigations and the said association will each contribute the sum of three hundred and seventy-five dollars (\$375).

For the investigation of the above-named irrigation problems of the Susan River, in Lassen County and vicinity, the said irrigation investigations and the said association will each contribute the sum of three hundred and seventy-five dollars (\$375), this exclusive of the work to be done by J. M. Wilson, C. E., special agent irrigation investigations, the total expense of which is to be borne by the said irrigation investigations.

For the necessary office work, maps, preparation of reports for publication, etc., the said irrigation investigations and the said association will each contribute the sum of six hundred and twenty-five dollars (\$625).

It is understood and agreed that the work is to be done under the supervision and direction of the expert in charge of the said irrigation investigations and the special agents appointed for that purpose.

The sums to be contributed by the said association shall be paid to the special agents of the said irrigation investigations as required on the presentation to said association of proper vouchers approved by the said expert in charge.

The said irrigation investigations of the United States Department of Agriculture agrees to publish immediately all of the report accepted by the Department and to pay all the expenses of such publication.

On July 21, 1900, the same parties entered into a supplementary agreement whereby each was to contribute \$375 for the study of the water supply, duty of water, etc., of Cache Creek, and the Water and Forest Association further agreed to devote a portion of a local subscription of \$500 to the same purpose. The additional amount so obtained for the investigations here reported was \$250.

AMOUNTS EXPENDED IN IRRIGATION INVESTIGATIONS IN CALIFORNIA DURING 1900.

The amounts and disposition of the funds devoted to this work are shown in the following table:

Sums expended in irrigation investigations in California.

| Purpose for which expended. | Contributed by California Water and Forest Association. | Contributed by United States Department of Agriculture. |
|---|---|---|
| Kings River | \$1,125 | \$375 |
| San Joaquin River..... | 1,125 | 375 |
| Salinas River | 375 | 375 |
| Yuba River | 375 | 375 |
| Honey Lake Basin..... | 375 | 500 |
| Cache Creek | 625 | 625 |
| Sweetwater River..... | | 750 |
| Los Angeles River | | 750 |
| Investigations on duty of water, southern California..... | | 250 |
| Experts in charge, maps, reports, etc..... | 625 | 1,500 |
| Preparation—printing, illustration, etc.—of the report (estimated)..... | | 7,000 |
| Total..... | 4,625 | 12,875 |

In addition to the above, individuals and local associations have contributed \$250 toward the expenses of work on Stoney Creek now being carried on by the Department of Agriculture, but not included in this report. The work in southern California was paid for entirely by the Department.

The University of California and Leland Stanford Junior University have taken much interest in this matter, have aided in completing the arrangements for the work, and are represented on the staff of agents employed in its prosecution.

EXPERTS IN CHARGE OF THE WORK.

The investigations were carried out during 1900 under the supervision of Elwood Mead, expert in charge of irrigation investigations, by the following staff of experts: William E. Smythe, Susan River; Marsden Manson, Yuba River; James M. Wilson, Cache Creek; C. E. Grunsky, Kings River; Frank Soulé, San Joaquin River; C. D. Marx, Salinas River; Edward M. Boggs, Los Angeles River, and James D. Schuyler, San Jacinto and Sweetwater rivers.

SUMMARY OF THE RESULTS.

The plan pursued in this investigation was to have each expert in charge base his conclusions on the facts gathered in his particular field, and these conclusions are made a part of the individual reports. A conference was had after the work had been completed which showed that there was a unanimity of opinion regarding the more important measures required to develop to the fullest extent the State's agricultural possibilities. The principal conclusions agreed upon at this conference are as follows:

It is the duty of the State—

(1) To fix the priority and limitations of every existing right to water, whether based on the ownership of riparian lands or on beneficial use.

(2) To determine the volume of unused or unappropriated waters.

(3) To declare unappropriated water State property and define the procedure whereby rights thereto may be acquired.

(4) To exercise adequate supervision and control when new appropriations are sought.

(5) To provide an office in which shall be kept a complete record of each perfected right, of each application, and of each permit for a new diversion or use.

(6) To divide the State into administrative divisions and districts based on drainage lines.

(7) To provide an efficient administrative system with proper officers for the distribution of the water supply among those entitled to its use.

SCOPE AND NATURE OF THE REPORTS SUBMITTED.

The combined reports as submitted will make a book of some 400 quarto pages, containing a large number of maps and illustrations. The nature and scope of the complete report are indicated by the table of contents and the extracts from the individual reports which follow:

CONTENTS OF THE COMPLETE REPORT ON IRRIGATION IN CALIFORNIA.

THE AGRICULTURAL SITUATION IN CALIFORNIA, BY ELWOOD MEAD:

The need of reforms.

Legislation a State matter.

The scope and purpose of this investigation—Duty of investigators—Plan of the work—Reasons for restricting discussion of water-right problems to irrigation.

Possibilities of irrigation in California—Irrigation in southern California—Irrigation in northern California—Diversity of products under irrigation—California, Egypt, and Italy compared.

Obstacles to development—

Prejudice against irrigation—Personal observations in the Sacramento Valley—California and Utah compared—Opposition to irrigation—Reasons for opposition to irrigation—The desire for large things—Controversies over district enterprises.

The dangers and abuses growing out of the recognition of riparian rights—Litigation over riparian rights—Legislation respecting riparian rights in English colonies—Canada; Province of Victoria, Australia, and Province of New South Wales, Australia.

Uncertainty regarding existing rights—Effect of posting and filing notices—The nature of a water right—"Appropriation" a term found only in irrigation laws of the United States—Appropriations for sale, rental, or distribution.

Public control over the water supply—Abstract of litigation over rights to Kings River.

The way out—Attorneys and courts not responsible—The need of some simpler and more effective method of settling rights—Should appropriations be made perpetual, or be limited, like franchises, to a number of years?

Concluding suggestions—Jurisdiction of special tribunal—The importance of adequate preliminary surveys and investigations—The favoring conditions for these adjudications—The protection of rights to water—The acquirement of rights hereafter—Navigation rights on Sacramento and San Joaquin rivers—Term of office—Benefits of adequate laws.

THE IRRIGATION PROBLEMS OF HONEY LAKE BASIN, CALIFORNIA, BY WILLIAM E SMYTHE:

Introductory—History and resources—Description of the country—Climate and products—Surrounding resources—A variety of problems.

The water supply of Honey Lake Basin—Honey Lake serves to measure the supply—Character of watershed—Storage sites—Eagle Lake—Recent water measurements.

Appropriation and distribution of water—

The law of appropriation at work—Claims on Susan River—Claims to Willow Creek—Balls Canyon claims—Claims to Long Valley Creek—The Lake district—Claims to waters of Eagle Lake—Recapitulation and review.

The duty of water—The distribution of water.

THE IRRIGATION PROBLEMS OF HONEY LAKE BASIN, CALIFORNIA, ETC.—Continued.

Litigation—The Susan River communities—Cause and character of lawsuits—
The “Big water suit”—Some bewildering decisions—The stipulation as to
storage—The building of the “Colony Dam”—Merits and lessons of the con-
troversy—Contracts of irrigation companies.

The needed reform of California laws—Private or public ownership of water.

The larger irrigation problem of the basin—The failure of past enterprises—The
water-right system—The cooperative canal—Possibilities of the Carey law—
State and national works—Hope in the district system.

Local aspect of national questions—The forest question—The homestead and
desert-land laws.

Conclusions.

FEATURES AND WATER RIGHTS OF YUBA RIVER, CALIFORNIA, BY MARSDEN MANSON:

Watershed of Yuba River—Physical features and geology.

Nature, origin, and acquisition of water rights in the basin of Yuba River—Claims
filed on Yuba River and its tributaries.

Storage of water in the basin of Yuba River—Artificial storage facilities on Yuba
River (South Fork, Middle Yuba, North Yuba)—Forest storage—Develop-
ment of power on Yuba River.

Opinions upon points submitted in circular letter.

Appendix—

The use of the water of Yuba River, by H. D. H. Connick—
Browns Valley irrigation district.

Practice of irrigation—Duty of water—Character of crops—Irrigation of
alfalfa—Irrigation of orchards—Irrigation of hay and grain—Irriga-
tion of corn and strawberries—Methods used by Sam Sing Company—
Loss by seepage and evaporation—Loss by unskillful irrigation and
insufficient preparation of land—Measurement—Season of irrigation—
Soil—Effect of irrigation on soil—Effect on health—Value of land—
Methods of distributing the water—Duty of water around Auburn—
Cost of raising olives and peaches—Value of produce—Cost of raising
peaches.

Principal ditches and reservoirs in the basin of Yuba River—

South Yuba Water Company—The South Yuba Canal system—The
sale of water—Value of the property.

Summit Water and Irrigation Company.

Kate Hayes Company.

North Bloomfield Gravel and Mining Company—Irrigation.

Marysville and Nevada Power Company—Canals—Reservoirs.

Excelsior Water and Mining Company—Rough and Ready—New
Town Ditch—Woods Ravine Ditch—Pleasant Valley Ditch—
Ousley Bar Ditch—Farm Ditch—Spencerville Ditch—Dams—
Reservoirs—Rights in Deer Creek—Water rights in South Yuba.

New Blue Point Mining Company's ditch.

Power stations in the basin of Yuba River.

IRRIGATION INVESTIGATIONS ON CACHE CREEK, BY J. M. WILSON:

Cache Creek.

Storage.

Power possibilities of Cache Creek.

Soil.

Wheat growing.

Appropriation laws of California.

Irrigation from Cache Creek.

IRRIGATION INVESTIGATIONS ON CACHE CREEK, BY J. M. WILSON—Continued.

History of other attempted appropriations and consequent litigation—Pumping plants—Duty of water.

Present conditions and possibilities of Yolo County.

Definitions of titles to water.

REPORT ON IRRIGATION PROBLEMS IN THE SALINAS VALLEY, BY CHARLES D. MARX:

Irrigation problems in the Salinas Valley.

Claims to the waters of Salinas River and its tributaries.

Storage.

Use of underground waters.

Duty of water.

Methods of distribution.

Irrigation being done in Salinas Valley.

Cases on irrigation and water rights arising in the counties of Monterey, San Benito, San Luis Obispo, decided by the California supreme court—*Zimmier v. San Luis Water Company*—*Green v. Carotta*—*Burrows v. Burrows*—*Smith v. Corbit*—*San Luis Water Company v. Estrada*.

Summary.

Appendix—Water-bearing gravels and formations tributary to the underground water supply of the Salinas Valley in Monterey County—Conclusions.

IRRIGATION FROM THE SAN JOAQUIN RIVER, BY FRANK SOULÉ:

Introduction.

A brief history of the development of irrigation in California and in the San Joaquin Valley.

Physical features of the San Joaquin Valley—The San Joaquin River—The soils in the drainage area of San Joaquin River—Rainfall—Flow of the river—Climate—Products.

Irrigated tracts in the valley, and possible extensions.

Fresno River.

Chowchilla Creek.

Estimate of total area of land which might be irrigated from San Joaquin and Fresno rivers and Chowchilla Creek.

Appropriation and distribution of water—Summary.

Evolution of water laws in California—Statutory laws relating to water rights—Rights of riparian proprietors—The Wright district law.

Litigation over water rights on San Joaquin and Fresno rivers and Chowchilla Creek—In the superior court of Fresno County—In the superior court of Madera County—In the superior court of Merced County—In the superior court of Mariposa County.

Investigations in the field—

Canals on San Joaquin River—Upper San Joaquin River Canal Company—The Aliso Canal—The Chowchilla Canal—The Blyth Canal—The Eastside Canal—The James Canal—The irrigation system of the San Joaquin and Kings Rivers Canal and Irrigation Company.

Canals on Fresno River.

Canals on Chowchilla Creek—Sierra Vista Vineyard Company—Bliss Canal.

Distribution of water among canals.

Distribution of water among irrigators.

Methods of irrigating.

Duty of water.

Answers to a circular letter of inquiry concerning irrigation matters.

Conclusions—Methods of filing and recording claims to water—Adjudication of water rights—Influence of the doctrine of riparian rights on the success of irrigation—Stream control—State engineer—When claims should be recorded—Conservation and use of flood water, and legislation thereon.

WATER APPROPRIATIONS FROM KINGS RIVER, BY C. E. GRUNSKY:

Kings River—Watershed—Valley section of Kings River—Lands irrigated—
Tulare Lake—Rainfall and climate—The flow of Kings River—Water storage—
Claims to water—Insufficiency of the record.

Water laws and water rights.

Water-right litigation.

Kings River Canals—San Joaquin and Kings River Canal—Sanger Flume—
Ditches of Centerville Bottoms (Rice Ditch, Jacobie Ditch, The Dunningan-
Byrd Ditch, Hanke Ditch, Cameron Ditch, Dennis Ditch, Byrd Ditch, The
New Jack Ditch, Mitchell Ditch, Fink Channel, Jack Ditch, Fink Ditch)—
Kings River and Fresno Canal—Fresno Canal—Centerville Ditch—Sweem
Ditch—Fowler Switch Canal—Centerville and Kingsburg Canal—Alta Irriga-
tion District—Selma Irrigation District—Sunset Irrigation District—Carmelita
Ditch—People's Ditch—Mussel Slough Ditch—Last Chance Ditch—Leinberger
Slough—Lower Kings River Canal—Rhoads Canal—Tulare Lake Bed canals
(Kings Canal, Westside Canal, Clausen & Blakeley Canal, Lovelace Canal)—
Emigrant Ditch—Liberty Canal—Murphy Slough Association—Millrace
Canal—Turner Ditch—Reed Ditch—Riverdale Ditch—Burrell Ditch—Round-
tree Ditch—Laguna de Tache Canals—Crescent Canal—Stimson Canal—
Calamity Ditch—Hite Ditch—James Eastside Canal—James Westside Canal.
Pump Irrigation from Fresno Slough—Whiteside pump—Mitchler pump—The
Lee pump—Borland pump.

Methods and practice of irrigation.

The present situation—Need of a department for water control and investigation.

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Appendix—Evaporation experiments on Kings River.

A STUDY OF WATER RIGHTS ON THE LOS ANGELES RIVER, CALIFORNIA, BY EDWARD
M. BOGGS:

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Los Angeles—Elms *v.* City of Los Angeles—Vernon Irrigation Company *v.*
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PROBLEMS OF WATER STORAGE ON TORRENTIAL STREAMS OF SOUTHERN CALIFORNIA
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Introduction.

Sweetwater River—Physical characteristics—The duty of the stream.

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mined—Primary rights—Secondary rights.

PROBLEMS OF WATER STORAGE ON TORRENTIAL STREAMS OF SOUTHERN CALIFORNIA
AS TYPIFIED BY SWEETWATER AND SAN JACINTO RIVERS, ETC.—Continued.

Litigation over water rights, its causes, cost, and influence on irrigation development, and the principles established by the decisions rendered—The National City water-rate case—Water-rate case of Lanning *v.* Osborne et al.—Appeal from ordinance of supervisors fixing rates—The National City case, establishing that domestic use is not superior to irrigation—The Sharpe case—The Hale water-right case—Cost of water litigation.

Rights for storage and underground waters.

Nature of an appropriation of water.

Return seepage and its effect on water rights.

Methods of distribution and duty of water—Water-right contracts, water rates, etc.—The fixing of water rates.

Hemet Creek—Claims to water on Hemet Creek—The Hemet dam—The irrigated lands—Water-right contracts.

General conclusions.

EXTRACTS FROM REPORTS OF AGENTS AND EXPERTS IN CHARGE
OF THE INVESTIGATIONS.

**EXTRACT FROM REPORT ON THE AGRICULTURAL SITUATION IN
CALIFORNIA.**

By ELWOOD MEAD,

*Expert in Charge of Irrigation Investigations, Office of Experiment Stations, U. S.
Department of Agriculture.*

THE NEED OF REFORMS.

When the mission fathers at San Diego turned water on the thirsty soil of southern California they began an industrial development whose history shows a strange mingling of romance and business enterprise. The altruistic public spirit manifested by the cooperative colonies of southern California has been offset by speculative greed in appropriating water elsewhere. The remarkable ability displayed by engineers and irrigators in diverting and using streams has been accompanied by equally marked disregard of the experience of other irrigated lands in framing laws to protect the interests thus created. Ability and energy in material development have gone side by side with a direct violation of important economic principles necessary to enduring success.

The present agricultural situation is the natural result of this combination of favorable and adverse conditions. Although irrigated land in this State has a greater value than in any other arid Commonwealth, the watered area is not being extended. While water for irrigation sells for a higher price than can be realized elsewhere, the volume which runs to waste is greater than the volume used. Few States have been blessed by nature as has California, yet irrigation development is at a standstill, and population in some of the agricultural districts has, during the past ten years, shown a decrease. There is manifestly something at fault, and it is fortunate that the time for reflection, offered by the present stagnation, has been utilized to investigate the causes which have created the uncertainty over titles to water and controversies over rates and rights to its use. It is hoped

the investigation will also lead to an inauguration of needed reforms, and to such changes in existing laws as are necessary to protect investments in irrigation works, and to define and make secure the rights of all who have interests in irrigated lands or the waters which fertilize them, as far as human agencies can accomplish these results.

In the reports which follow are given the results of the most comprehensive study yet made in this country of the social, legal, and economic problems created by the use of streams to reclaim arid lands. While it has been carried out under the direction of the Office of Experiment Stations of the United States Department of Agriculture, its effectiveness has been greatly increased through the financial aid extended by the Water and Forest Association and other local associations of the State. (See p. 13.) The appropriations for these studies made by Congress and the contributions of money and time by the public-spirited citizens of California indicate a growing recognition of the fact that irrigation is more than a matter of ditches and acres. It is beginning to be realized that the value of the irrigated farm depends as much on just laws and wise policies as on a fertile soil or ample water supply. No State illustrates the truth of this more than California, and no State affords a more instructive field for the prosecution of these investigations, both because of the possibilities of irrigated agriculture and the evils and abuses which have grown out of inadequate and imperfect legislation.

LEGISLATION A STATE MATTER.

An opinion seems to exist in the minds of some that this study of the legal problems of irrigation is destined to lead to a national law which would control rights to streams and in a measure overturn or unsettle existing ones. This is not the present or ulterior purpose of those in charge of these investigations. They do, however, hope to render effective service in the work of education. The enactment of laws to regulate the diversion and use of water has thus far been wholly a State matter. Existing rights are based on State laws and the decisions of State courts, and there is no reason to believe that these rights will be overturned or ought to be except as those most concerned approve. When there is a desire for change no legislative agency can respond so quickly and effectively to public sentiment as that of the State.

Since, therefore, the power to act and responsibility for action or failure to act rests with those directly concerned, and since action will not follow the recommendations of this report unless they commend themselves to irrigators as just and timely, those connected with this investigation have felt that the greatest service they could render would be to state their views candidly as they have gathered and presented the facts impartially.

THE SCOPE AND PURPOSE OF THIS INVESTIGATION.

The investigation made has aimed at a solution of the irrigation problems which now confront the agricultural interests of California. It has been carried on by eight students of irrigation of wide experience and recognized ability, each of whom, with his assistants, has gathered the available facts relative to the character, number, and value of water rights on the stream or streams included within his particular field of investigation and the methods employed in the distribution and use of the water supply. To get these facts required a study of the laws and customs, both State and local, under which water is put to use, as well as of the prevailing physical conditions and the engineering problems which they entail. The combined reports present the irrigation situation in California in a concrete form. The lessons drawn, while based on the researches in restricted areas, apply with equal force to the entire State, because the streams studied are typical ones. Nor are these reports of value to California alone. The principles which should govern the ownership and distribution of rivers are universal in their application, and the experience of irrigators in the San Joaquin and Sacramento valleys has been the experience or will be the experience of irrigators in other States where similar laws and methods prevail.

DUTY OF INVESTIGATORS.

The situation demands that those engaged in these studies should be more than reporters. It is their province to interpret the facts gathered and state fearlessly the views held on each important issue involved. It is not expected that these opinions or the measures recommended for adoption will be approved by all. The interests affected are too diverse and the inherited or acquired ideas regarding stream ownership or control too widely apart to render this possible. This makes it all the more important that those who attempt to unravel these complications should not only study them with open minds but should state their conclusions without restraint. This privilege will be exercised in this introduction, where the writer considers himself as one of the investigators, with a roving commission which confers upon him the privilege of giving his personal experience and impressions, as well as of presenting the conclusions reached by reading the reports of his associates. Some of the views herein expressed are known to be opposed to those of gentlemen for whose judgment no one has a higher regard than myself, but no one ought to object to a candid, temperate statement of convictions reached after much study and expressed with a hope of promoting the State's development. A report written in this spirit ought not to offend, even if it fails to convince. * * *

Within the limits thus fixed by the instructions each of the gentlemen in charge of these investigations has been a law to himself. He has gathered his facts and stated his conclusions without advice or direction from any source. * * *

REASONS FOR RESTRICTING DISCUSSION OF WATER-RIGHT PROBLEMS TO IRRIGATION.

While this investigation deals primarily with the problems of irrigated agriculture, the fact is not lost sight of that other important industries have rights to the use of streams. Placer miners, owners of power plants, and cities and towns which need water for domestic purposes and to turn the wheels of factories have a common interest with the irrigator in securing such changes in existing conditions as will provide for the final establishment of titles to the water used and protect those titles in time of scarcity. At present it is notorious that anyone attempting to utilize the streams of California for any purpose has, because of indefinite and conflicting water laws, to add to the ordinary or legitimate risks and expenses of his enterprise a large and continuing outlay for litigation to maintain his right to water. All this affects injuriously not simply irrigation investments but any enterprise which depends on the right to use water. A just system of laws will take into account the needs of all interests. While this report is restricted to a consideration of the rights and needs of the irrigator, this must not imply that other rights are not regarded as important or not entitled to impartial recognition. Exactly the reverse is true. Owing to the fact that this work is largely paid for from the appropriations of Congress for irrigation investigations other equally important subjects are excluded from the report.

POSSIBILITIES OF IRRIGATION IN CALIFORNIA.

A seven years' record of the flow of Sacramento River, measured above the confluence of this stream with the San Joaquin,¹ shows that during that period 181,553,808 acre-feet of water ran into San Francisco Bay. The mean discharge for each of these years was nearly 26,000,000 acre-feet. Based on a duty of water of 2 acre-feet per acre, this mean discharge would adequately irrigate 13,000,000 acres.

¹The table given below shows the total discharge of the Sacramento River, at Colinsville, for the seven years from 1878 to 1885, inclusive. It is taken from "Physical Data and Statistics of California," report of Wm. Ham Hall, State engineer, 1886.

| Year. | Flow in acre-feet. | Year. | Flow in acre-feet. |
|---------------|--------------------|-------------------------------|--------------------|
| 1878-79 | 26,414,302 | 1883-84..... | 29,947,038 |
| 1879-80 | 32,205,831 | 1884-85..... | 17,926,997 |
| 1880-81 | 31,922,750 | | |
| 1881-82 | 25,503,305 | Mean for the seven years..... | 25,936,258 |
| 1882-83 | 17,633,585 | | |

But it does not require 2 acre-feet of water to irrigate an acre of land in Sacramento Valley. Probably 1 acre-foot would answer. Based on such a duty, the river would supply nearly 26,000,000 acres. As near as can be determined, the irrigable area of the valley is far less than that, probably not more than 12,000,000 acres. Hence the water which runs to waste every year from the Sacramento Valley would more than suffice to irrigate every acre that can be reached by canals from the river or its tributaries.

An effort was made to secure the discharge of San Joaquin River, but without success. From the records of the gagings made on the head waters and on a number of its tributaries it seems probable that the total flow of this stream is approximately one-half that of the Sacramento, and that the waters of this river and its tributaries, if conserved and economically used, would irrigate several millions acres of land.

The loss of water is not the only injury which its escape works to the State. Many thousands of dollars have been expended in the construction of levees to keep these floods within their banks, and many thousands of acres of fertile land are rendered unproductive and unhealthful by their annual overflow. It is a matter well worthy the consideration of the State whether the money spent in constructing levees, drainage canals, and other reclamation works can not be expended to better purpose in the storage and distribution of this water at higher levels—instead of attempting to counteract the effect to remove the cause.

The most important industrial problem now before the people of California relates to the storage, distribution, and economical use of its streams. The successful solution of this problem in the great interior valley we have been considering will make of California the greatest agricultural State in the Union, with a population and productive wealth so far beyond what now exists that one can not discuss it without seeming exaggeration. The extraordinary fertility of its soil, which has permitted the continuous growing of one crop for fifty years without its complete exhaustion; the marvelous climate, which makes winter a period of seedtime instead of stagnation; which gives to its farmers nearly all the products of the tropics, with the climate of the temperate zone; which by withholding moisture during the period of harvest relieves husbandmen from the most serious vicissitude of regions of ample rainfall, presents a combination of attractions which people of less-favored regions can scarcely realize and which the people of California do not fully appreciate. It is only through irrigation that all the advantages of soil and climate can be fully secured, and when this is provided the State is certain to be the home of a dense population because of the opportunities for employment and support which it will create.

IRRIGATION IN SOUTHERN CALIFORNIA.

In order to realize what can be done with water in California one must go to the southern part of the State, where land not worth \$5 an acre in its original condition has sold for \$1,700 an acre when provided with water and planted to orange trees; where valleys which were originally a desert of sand and cactus, producing nothing more valuable than stunted grass, and where one whole township would not keep a settler and his family from starving to death if compelled to cultivate it in its natural state, have been transformed into the highest priced and most productive agricultural lands in this country; where water which formerly ran unused to the ocean is worth for irrigation alone 10 cents per 1,000 gallons; where \$3.50 an inch, and 40 cents an inch extra for its carriage, was paid last year for a twenty-four hours' flow, and where \$50,000 was recently paid for a water right for 50 inches. The water used in the irrigation of 10 acres of orange land last year cost more than the money required to purchase an equal acreage of the best farming lands of Iowa. Before the land and water of this part of the State were united, neither was valuable; since their union the citrus-fruit lands of southern California have brought net annual returns of \$200 to \$450 an acre, and this year's crop will be worth, approximately, \$10,000,000,¹ the whole making a record of productive capacity and the creation of agricultural wealth not surpassed in this or any other country.

These are not the chief benefits which irrigation has conferred on southern California. A far larger gain has come with the beautiful landscapes created in these deserts by the oases of fruit and foliage, which, with the matchless healthfulness and charm of the climate, have made this section the resort of health and pleasure seekers from all parts of the globe. The climate alone would not have accomplished this. Limited trains on the transcontinental lines from the East would not be crowded if Pasadena looked now as it did when first viewed by the mission fathers, and before they began at San Diego the work which makes this valley now so justly famous. The cities of Los Angeles, Redlands, and San Diego are just as much creations of irrigation as the orange groves which surround them. Whatever may be true of the remainder of the State, there is no question that southern California's present prosperity and its future growth depend largely on the distribution and use of its water supply.

IRRIGATION IN NORTHERN CALIFORNIA.

The region south of Tehachapi shows what irrigation has accomplished. On the other hand, the great interior valley north of those mountains illustrates its latent possibilities. Reference has been made

¹Letter from Frank Wiggins, secretary Los Angeles Chamber of Commerce.

to the fact that enough water leaves the valleys of the Sacramento and San Joaquin to irrigate between ten and fifteen millions acres of land. This escaping water is nothing but a source of expense and loss to the State. It becomes interesting to determine what it would be worth if used in irrigation. The yearly rental for water supplied by the South Yuba Water Company is \$45 an inch. It is evidently worth more to irrigators, or this price would not be paid. How many acres an inch will irrigate is not known, as reports vary from 3 to 10 acres. Assuming the average to be 5 acres, the water thus used is worth \$9 an acre. Much of the land irrigated from the North Fork Ditch, on American River, would not pay interest on \$1.25 an acre if it had to depend on rainfall alone. Supplied with the needed moisture it sells for \$1.50 an acre. The annual rental of water for the colonists at Orangevale is \$4 an acre for citrus fruits, \$3 an acre for deciduous fruits, with an added charge of \$1 an acre for maintaining the irrigation system. The annual water rental of lands seeded to alfalfa is \$3 an acre; that for small grain \$1 an acre, with, as before, \$1 an acre added for maintaining the canal and distributing works. The orange crop from one 10-acre tract in this colony sold last year for over \$7,000. There was expended for labor in its cultivation \$2,000, and the land itself is valued at \$350 an acre. Comparing the financial returns, the number of men employed, the increased productiveness and value of irrigated land, with the scanty population, diminished fertility, nonresident landlordism, and the yield of 3 sacks of wheat per acre, which was the average over a considerable portion of the Sacramento Valley last season where irrigation is not practiced, shows what might be accomplished by the use of the water which now runs to waste. These are not isolated or exceptional returns. Several others equally large came under my personal notice, while one crop of citrus fruits brought the surprising sum of \$1,800 an acre.

One of the needs of northern California is more diversified farming. Rotation of crops is one of the most effective means of preserving the fertility of the soil. This result is now secured in fruit growing by the use of fertilizers, but there is a limit to the profitable extension of the acreage devoted to fruits. There is, however, no limit to the profitable extension of that kind of agriculture which makes each home largely self-supporting; where each farmer grows nearly everything he consumes; where his farm supplies him with his poultry, butter, eggs, and meat; where he grows his own hay and has his own pasture and his own orchard and garden. Every acre seeded to alfalfa is a direct gain to the State. It stops the impoverishment of the soil and is another step toward making the State wholly independent of the outside world. More than this, it replaces unprofitable cultivation with a kind which pays. How well it pays was shown by numerous reported yields of 11 tons of alfalfa hay per acre, worth \$5 per ton.

The report of Professor Soulé states that water rates in the San Joaquin Valley range from \$2 to \$6 per acre where these rates were not fixed by supervisors and are not being contested. Such rates, on a duty of 5 acres to the inch, would mean a value of \$10 to \$25 per inch. Wasted water is therefore wasted wealth. The loss to the State in productive capacity can scarcely be measured, but the following comparisons with other irrigated countries will show something of its character.

DIVERSITY OF PRODUCTS UNDER IRRIGATION.

Within a radius of 5 miles in the Sacramento Valley I saw every product of the temperate and semitropical zones which I could call to mind. Apples and oranges grew side by side, as did oak trees and almond trees. There were olives from the South and cherries from the North. A date palm seemed equally at home with an alfalfa meadow; figs and tokay grapes were apparently as much in their element as the fields of wheat and barley or the rows of indian corn, some of the stalks of which measured 15 feet in height. All of these things could have been grown on a single acre, and doubtless have been. It is a sinful waste of opportunities to continue using thousands of acres of this land to grow wheat, which steadily impoverishes the soil and robs the pockets of its owners. The irrigable lands of California are no place for bonanza farms. They are far better suited to the creation of 10 and 20 acre homes.

CALIFORNIA, EGYPT, AND ITALY COMPARED.

There are more acres of irrigable land in the San Joaquin Valley than are now watered in Egypt from the Nile, where agriculture alone supports over 5,000,000 people, maintains a costly government, and pays the interest on a national debt half as large as that of the United States. The area which can be irrigated from the Sacramento is about equal to that irrigated in Italy from the Po. The population of the California valley is about 20 people to the square mile. In the Italian valley it is nearly 300 people to the square mile. The irrigated lands along the Nile support 543 persons to the square mile. Such a settlement of the Sacramento Valley would more than double the present population of the State. It is believed that an irrigated square mile in this valley will support as many people in comfort as now live in either of the other districts referred to, because neither of these surpasses California in the diversity or value of its products or the excellence of its markets. * * *

BENEFITS OF ADEQUATE LAWS.

The creation of a code of irrigation laws which, by their justice and effectiveness, will be worthy of the people of California, will do more than all other influences combined to multiply the number and increase

the value of rural homes, and will mark the beginning of a new era of emigration to this attractive and lovable State. It is an opportunity for the exercise of constructive statesmanship which rarely appears in the life of any Commonwealth. The task is not to piece together the discordant fragments of laws and decisions which now control the use of rivers, but to create an irrigation code worthy of an enlightened and self-governing people. The effort to be made should not be limited to alleviating pressing ills, but to provide a system which will insure the peace and security of irrigated farms for generations to come. The possibilities which wait on success ought to enlist the wisest minds of the State. If they can do for California what Napoleon and Cavour did for Italy, what Deakin has done in part for Australia, and Dennis more effectively for Canada, they will inaugurate an economic revolution whose influence will be felt throughout the West. If the reform of irrigation laws can come as a part of the movement of trade and population toward the Pacific coast, which now seems inevitable, and of the material development of arid America by public and private enterprise, which is now being so strenuously advocated, the opening years of the twentieth century will be years of marvelous growth and prosperity.

EXTRACT FROM REPORT ON THE IRRIGATION PROBLEMS OF HONEY LAKE BASIN, CALIFORNIA.

By WILLIAM E. SMYTHIE,

Vice-President of the California Water and Forest Association.

INTRODUCTORY.

HISTORY AND RESOURCES.

The region on the eastern slope of the Sierra Nevada Mountains differs materially from all other parts of California. To the minds of its earliest pioneers these differences appeared to present an insuperable objection to the inclusion of Honey Lake Valley in the new State. They felt that the great mountain range had reared a natural boundary between the two slopes which men should respect, and, in consequence, sought by every means in their power to be left outside of California. The chief objection lay in the difficulty of communication between this remote region and the seat of government in the Sacramento Valley, especially in the winter season when legislation would be enacted.

Their first effort to free themselves from this embarrassment aimed at the formation of a new Territory, to which they gave the pleasant name of "Nataqua." Such a Territory was actually organized by a handful of settlers on April 26, 1856. The boundaries established included a large portion of Nevada as well as a part of California. By

a ludicrous blunder, arising from misunderstanding in regard to the exact location of the hundred and twentieth meridian of west longitude, the founders of the new Territory were themselves excluded, while a much larger population in western Nevada, which had not been consulted, were within the boundaries of the impossible Commonwealth. The code of laws adopted for the new political division disposed of the irrigation problem in the following brief paragraph:

SECTION 8. No person shall divert water from its original channel to the injury of any prior occupant.

Probably this provision was intended to refer not to the "prior occupant" of the water or the channel, as it reads, but to the occupant of the land along the stream, and was thus the first assertion of the riparian doctrine in this locality.

After the failure of this attempt to provide themselves with civil government the settlers petitioned Congress to be included in Nevada. In the meantime they assembled in mass meeting and adopted (February 13, 1858) a new code purporting to be "The laws of Honey Lake Valley." In this code the same provision for water appropriations was made as in the case of "Nataqua." The locality experienced various political vicissitudes, including an armed struggle (locally known as "The Sage Brush War") between the Nevada people and those of Plumas County, Cal., before it was safely and finally incorporated as a part of the Golden State in 1864. This was accomplished by the act of April 1 of that year authorizing the formation of the new county of Lassen, which took its name from the valiant pioneer.

DESCRIPTION OF THE COUNTRY.

The Honey Lake Basin lies in northeastern California between the Sierra Nevada Mountains and the State of Nevada. It is in the southern part of Lassen County, and separated only by the county of Modoc from Oregon. Its only railroad communication with other parts of California is by way of Reno, Nev., over the Nevada-California-Oregon Railway (narrow gage), the distance from Reno to the principal station in the valley being 80 miles. Although the extent of fertile soil and of potential water supply would be adequate to the support of a population, in country and in town, of at least 100,000 souls, and the character of surrounding resources and the demand for the natural products of the region would warrant it, the locality is but sparsely peopled, and even those who are there are forced to contend, through ceaseless litigation and neighborhood strife, for the comparatively small amount of water represented by the perennial flow of the streams. But the present population is decidedly prosperous, perhaps more so on the whole, and considering the amount of capital invested, than the agriculturists in any other part of the State. For the most part they are engaged in raising hay and live stock, principally cattle

and horses. Sheep and hogs are also very profitable. Natural hay is raised along moist river bottoms and in a large district known as "The Tules" on the western border of Honey Lake. On the sagebrush lands reclaimed by irrigation three crops of alfalfa are raised each season, the total yield ranging from 3 to 8 tons per acre, with 5 tons as a fair average. On small areas with skillful irrigation this average should be increased considerably. Wherever small orchards have been established they have brought good returns upon the investment, though years when late frosts injure the fruit are not infrequent. * * *

CLAIMS TO WATER IN HONEY LAKE BASIN.

It is interesting to bring together the entire list of claims made upon all of the waters entering into Honey Lake Basin from 1872, the date of the first record which appears on the books of the county, down to the spring of 1900. We shall then have completed our survey of the law of appropriation at work and be ready to consider the financial, social, and legal results.

Recapitulation of claims in Honey Lake Basin.

| District. | Miner's inches. | District. | Miner's inches. |
|-------------------|-----------------|-----------------|-----------------|
| Susan River..... | 955, 039 | Honey Lake..... | 821, 350 |
| Willow Creek..... | 6, 338, 535 | Eagle Lake..... | 14, 201, 400 |
| Balls Canyon..... | 565, 544 | | |
| Long Valley..... | 5, 737, 464 | Total..... | 28, 630, 932 |
| Baxter Creek..... | 11, 600 | | |

Here are total claims, under the rules prescribed by the California law, of the bewildering amount of 28,630,932 miner's inches. In southern California, where the rainfall is materially less than in Honey Lake Valley, the amount of water represented by 1 miner's inch of continuous flow, measured under a 4-inch pressure, is considered sufficient to irrigate 4 acres of alfalfa, or 6 acres of citrus trees, or from 8 to 15 acres of deciduous trees. Making a fair allowance for the difference in rainfall and climate and the consequently shorter season in Honey Lake Valley, we may take 1 inch to 8 acres as the reasonable duty of water for diversified crops in the latter locality. Upon this basis the amount of water claimed in Honey Lake Basin in accordance with the California law would irrigate an area of 229,047,456 acres, which is considerably more than double the irrigable land of our entire arid region, according to conservative estimates, and represents a larger area than that occupied by most nations in Europe. Of course it is not pretended that those who made these excessive claims so far deceived themselves as to imagine that the vast quantity of water to which they laid legal claim existed in Honey Lake Basin, or that they were bent upon the impossible task of irrigating the entire United

States from this point. But the fact remains that these claims were actually made in accordance with the law prescribed by the statutes of the State; and this fact has a significance which should not be lost sight of when we come to consider what measures of reform and constructive legislation will best promote and protect the irrigation industry.

The luminous fact which appears strikingly on the face of these statistics is that nobody knew how much water was available for appropriation, how much they needed, or, in the case of those who followed up their claims with actual diversion and use, how much they received. The foundation of any system of water rights is the appropriation. If the method employed in getting this is faulty, the inevitable result is public or private disaster, and it is likely to be both. It is clear from the foregoing figures that the experience of Honey Lake Valley shows that the California method of appropriation is utterly reckless and fraught with the gravest perils to industry and society. The evils to result from such methods might be expected to make themselves felt when the country is well settled and it becomes necessary to enforce the utmost economy in the use of the water supply. But we shall see that with probably no more than 20,000 acres under cultivation by means of irrigation these evils have already been sharply manifested, and that the troubles created and fostered by a system of bad laws have found no adequate cure in the courts.

THE DUTY OF WATER.

Among the important subjects to be dealt with in this report, according to the suggestions of the irrigation expert in charge, is that of the duty of water. Under any intelligent and permanent system of irrigation it is as necessary to fix upon some unit of water required for an acre of land as it is necessary in finance or industry to have a unit of value or of measurement. Men can not conduct exchange without dollars and cents to serve as units of value. They can not engage in manufacture or trade and ignore long measure and avoirdupois. There must be some basis of values, of weights, and of measures before men can deal intelligently and justly with each other in their daily transactions. In like manner it is necessary to fix upon some unit of water which shall represent the reasonable duty of that element in agriculture. This duty may be reckoned in miner's inches or acre-feet, as may seem most feasible, but it must be fixed in some terms, then recognized, accepted, and enforced; otherwise the whole right of appropriation rests on shifting sands.

The importance of the duty of water is recognized in most localities where irrigation is practiced. Honey Lake Valley is, however, a remarkable exception to this rule. Here there is no common agreement as to the amount of water required to irrigate an acre of land. If one were to interview all the irrigators in the valley he would prob-

ably receive a different estimate from each person. Their opinions would vary in accordance with the peculiarities of the soil, differences of crop, and even with the temperamental differences of individuals. Take, for example, two riparian proprietors living side by side. One of them will tell you that if you will guarantee to keep the stream in its original channel he will ask nothing more, preferring to depend entirely on natural seepage. His nearest neighbor will demand that the entire stream be diverted and spread over his farm, and will intimate that if anything less than this be done he will spend his last dollar in litigation. The same contrast in opinion is found when you talk with the occupants of bench lands away from the stream where the riparian element is entirely absent. One man wants all the water he can get, while his neighbor with similar soil and crops maintains that he gets better results with only half as much irrigation. When men differ about other subjects they leave the decision with the statutes or the administration. But in the matter of water each man is a law unto himself, and resents interference or advice as he would if the same were offered with regard to the training of his children.

Neither law nor custom has fixed the duty of water in Honey Lake Valley. Testimony touching this subject is sometimes offered in the courts, but there is no basis upon which just and consistent decisions may be rendered. The contracts of local irrigation companies make no reference to miner's inches or acre-feet. They merely agree to furnish water "sufficient to irrigate" a given number of acres. They promise that these acres shall be supplied with an "annual irrigation." They do not state whether this means water for one crop of alfalfa or for three. These vague arrangements are not supplemented by measurement of the heads of water turned into consumers' ditches. Everything is left to the superintendent and ditch riders, who try to apportion fairly the water that may be in the canals and reservoirs. These superintendents do remarkably well under the circumstances, but their troubles are as numerous as those of the Chinese Emperor. There can be no justice in water distribution under such a plan. Indeed, injustice is the only possible result. The man who makes loudest complaint receives most water, while the one who is most patient and considerate is the certain sufferer whenever the supply is short. The trouble is due to the absence of any common agreement upon the reasonable duty of water. In other parts of the arid region there is such common agreement, established by custom and enforced by law.

THE DISTRIBUTION OF WATER.

The California statutes make no provision for the distribution of water among rival ditches or different consumers from the same ditch. Aside from the brief paragraph on priority—"first in time, first in right"—there is nothing which bears even remotely upon the matter.

Everything is left for the irrigators to settle among themselves. This results in confusion and in bitter quarrels among neighbors. This condition of affairs must grow constantly worse as more land is brought under cultivation, ditches extended, and appropriations increased. Each man manages his own headgate. His object is to get all the water he possibly can. We have already seen that he has no means of obtaining exact information in regard to the status of appropriations or the duty of water. All he knows—all he can possibly know under the circumstances—is his own necessity. Even as to this he is liable to be led astray, since nothing has been done to give the people of this remote locality the benefit of lessons which modern science has so generously conferred on many other communities.

The consequence is pitiable. It is chaos; it is anarchy.

The sins of the law are visited on unoffending neighbors. Enterprise is balked and investment brought to ruin. One neighbor shuts down the headgate of another and stands over it with a shotgun. Retaliation follows upon provocation, and the evil passions so aroused invent new provocation and devise new methods of retaliation. A reservoir is built in the mountains to store the flood waters, that they may be turned later into the channel of the stream and then diverted upon the lands of those who made this prudent provision to supplement their share of the perennial flow. But when the water is turned down old dams are raised to intercept the increased supply, and the water thus lost to those who furnished it. Costly works of diversion, built without injunction, and even with the apparent approval of the community, are attacked and rendered useless by men who act upon the advice of their attorneys. It has come to be practically recognized that there is no law but force, and that when this law has exhausted the resources of its physical demonstration by overt acts the final resort is to the courts. We shall see how inconclusive and unsatisfactory a method this furnishes of settling the endless disputes, and how, after costly lawsuits and hurtful agitation, the quarrel travels back in a circle until it comes again to the point of physical violence.

“Because the good old rule
Sufficeth them, the simple plan,
That they should take who have the power
And they should keep who can.”

The fault lies not with the people, nor with the lawyers, though the latter inevitably fatten upon the misfortunes of the community. The fault lies with the irrigation laws of California, which are notable alike for what they contain and what they omit. If deliberately devised to plague the people, no system which man's evil genius could invent would effect the result more surely than that system which invites them to make such reckless claims as we have seen in the case of Honey Lake Valley and then leaves them to fight it out to the bitter end. * * *

THE LARGER IRRIGATION PROBLEMS OF HONEY LAKE VALLEY.

While a good system of administration would eliminate nearly all friction and litigation among water users in Honey Lake Basin, and to that extent furnish encouragement for future enterprise, it would not of itself solve the large irrigation problem of the valley. There are now about 20,000 acres in cultivation under ditches. This is practically the limit of the area that may be reclaimed by small works depending upon the perennial flow of streams. The larger problem is concerned with the reclamation of a great area of sagebrush lands extending from the foothills of the Sierra Nevada Mountains to the neighborhood of Pyramid Lake, in Nevada. This district includes more than 200,000 acres of arable land. What portion of it would be actually susceptible of irrigation in case the water supplies of the region were developed to their fullest capacity has not been definitely determined, but the area which might be reclaimed under these conditions would make homes for many thousands of people and support a very considerable railroad and commercial traffic.

THE FAILURE OF PAST ENTERPRISES.

The opportunity which exists here for large enterprises has not failed to attract the attention of the public in the past. There have been several periods of active effort during the past twenty years. This is the significance of the vast claims which have been noticed in earlier pages of this report. The scene of these efforts has included all the large sources of water supply—the headwaters of Susan River, Eagle Lake, Balls Canyon, Long Valley, and Skedaddle Creek. A conservative estimate of the investment represented by all these undertakings would be \$500,000, and perhaps double that sum would be no exaggeration if the interest accumulation were included. For all that expenditure not more than 5,000 acres are actually irrigated from the systems which were begun, so that it might be said that for each acre irrigated by these undertakings from \$100 to \$200 was spent in cash. In view of the fact that the average first cost of irrigating land throughout the arid region, as shown by the census of 1890, was \$8.15 per acre, this would argue that there have been serious miscalculations or unusual disasters to contend with in Honey Lake Basin. Such is the actual fact. Of the many large enterprises projected or undertaken, only one has anything substantial to show for the results. Even this is far from completion and groaning heavily under the burdens imposed by unfavorable conditions.

The failure of past enterprises was chiefly due to two facts. In the first place, everything was undertaken without sufficient knowledge, since the State has left its citizens wholly in the dark regarding the irrigation industry. Without scientific investigation of water resources and intelligent public supervision of projected works, the tempting

opportunities for reclamation and settlement offered by the natural conditions of this basin proved simply an invitation to disaster. Large sums were expended in trying to get water from sources and by methods which were problematical at best. Costly earth dams were erected where they could not hope to withstand the first flood. The result was pecuniary loss for investors and disappointments and hardship for settlers. These misfortunes, which would have been prevented by a system of administration like that of Wyoming, gave the country a bad name and injured the entire community.

In the second place, it has proven extremely difficult to command large capital for the irrigation industry. This is due in part to the uncertainties arising from the California law, but yet more to the ill repute of irrigation securities in general. These enterprises require large sums and, even under the most favorable conditions, the returns are likely to be long delayed, since much time is necessarily consumed in establishing the industrial economy of a new country and bringing it to a point where it may pay regular dividends to capital. The results of private investment in this field have been such as to lead many conservative men to favor some form of public enterprise, though opposed to this method in other lines.

But in spite of past failure the rich lands of Honey Lake Basin must be reclaimed. The territory is needed for the homes of men, and the desert must be made to give place to the field, the garden, and the orchard. * * *

EXTRACT FROM REPORT ON FEATURES AND WATER RIGHTS OF YUBA RIVER, CALIFORNIA.

By MARSDEN MANSON, C. E., Ph. D.,

Member Board of Public Works, San Francisco, Cal.

WATERSHED OF YUBA RIVER.

Yuba River is a tributary of Feather River, entering the latter stream at Marysville, 30 miles above its mouth. The Yuba drains about 1,357 square miles of the western slope of the Sierra Nevada, comprising portions of Sierra, Nevada, Plumas, and Yuba counties. The extreme length of the watershed is about 60 miles and the extreme width 36 miles; in addition to this length are about 11 miles of channel in the valley between the foothills and Feather River. In size Yuba river is fourth in the Sacramento Valley. Its extreme low-water discharge is about 360 cubic feet per second;¹ mean winter

¹This is not as small as the natural discharge would be. The large mining companies—the South Yuba Water Company, the North Bloomfield, Milton, Eureka Lake—and others store quite large volumes of water during the winter and spring months, the use of which during periods of low water forms a considerable portion of late summer and early autumn discharge.

discharge 1,500, and flood discharge 26,000 cubic feet per second.¹ The river for the lower 10 miles of its course in the foothills is much filled up with hydraulic mining débris, estimated at many millions of cubic yards, and is between levees which have been raised from year to year to meet the filling up of the area between them. The channel in the lower foothills has been filled more than 100 feet deep with cobbles and gravel. The channel of the river from the foothills to the mouth at Marysville lies over a surface recently built up of gravel, sand, and clay from the mines above. The channels are irregular and change from winter to winter, and sometimes during the summer.

It is therefore impracticable to establish low-water gaging stations which would serve for more than one summer and fall, and which would be suitable for winter or flood-stage gagings. The changes in the bottom and in the positions of the channel are so great that gagings at the flood stages of the river would be unsatisfactory, and, if undertaken from boats, highly dangerous, if not impossible.

Its drainage basin is subdivided into five smaller ones, namely: The North Fork, with a drainage area of 491.6 square miles; the Middle Fork, with a drainage area of 218 square miles; the South Fork, with a drainage area of 360 square miles; Deer Creek, with a drainage area of 89.6 square miles, and Dry Creek, with a drainage area of 105.5 square miles. In addition to these areas, 92.5 square miles drain into the main stream above the 100-foot contour.

Dry Creek joins the river from the north just as it leaves the foothills, the others having united in the mountains. The forks are perennial in flow, but the discharge of the two creeks named becomes insignificant in the late summer and early autumn.

The Sierra foothills as they merge into the valley have an elevation of about 100 feet above tide. The watershed rises gently in rounded and broken mountains to the crest of the Sierras, which at the headwaters of the Yuba has a mean elevation of about 8,200 feet, with peaks rising to 9,100 feet. From Mount Lincoln, a point common to the watersheds of Yuba, American, and Truckee rivers, to some $2\frac{1}{2}$ miles northeast of Mount Webber the summit of the Sierras divides the watershed of Yuba River from that of Truckee River, which discharges into Humboldt basin. Farther on, beyond Mount Webber, there is a secondary crest which divides the watersheds of Yuba and Feather rivers, the watershed of the latter stream reaching farther east to a less elevated divide, in which the passes are lower than those in the easterly crest. * * *

FOREST STORAGE.

On the South Fork of the North Fork of Yuba River we have a watershed area of 139 square miles, which was gaged on September

¹ Extreme flood discharge estimated by Mr. Hubert Vischer, assistant engineer, United States Engineer Corps, at 125,000 cubic feet per second. House Doc. No. 431, 56th Cong., p. 12.

19, 1900, after three successive seasons of deficient rainfall, and gave a minimum run off of 113 cubic feet per second, or 0.8 cubic foot per second per square mile. This area is well covered with timber and brush, and in 120 days gives a minimum run off of 1,441,152,000 cubic feet. The drainage basin of the North Fork is more heavily timbered than the basin of the other forks, and consequently has a deeper soil, and, although only one-tenth the total drainage area, it furnishes 75 per cent of the low-water flow of the entire drainage basin above Parks Bar.

On the South Fork, above Lake Spaulding, there is a watershed of 120 square miles, which has heretofore been described as comparatively bare of timber, and the timbered areas which once existed have been cut off. The run off of this area is practically nothing for one hundred and twenty days each year, due to this absence of forests and brush. If this area were afforested and gave a minimum run off of 0.8 cubic foot per second per square mile, the discharge would be 100 cubic feet per second, or equivalent to 1,036,800,000 cubic feet effective storage capacity, a discharge more than equivalent to one-half the storage capacities of all the reservoirs above Lake Spaulding dam. These aggregate 1,375,000,000 cubic feet, and the low-water discharge of 100 cubic feet per second for one hundred and twenty days is equivalent to a storage capacity of 1,036,000,000 cubic feet. As the basis of the above estimate is the extreme low-water discharge, it is safe to assume that by afforesting the watershed this costly and extensive system of reservoirs might be safely drawn upon for double their present capacity. When this reasoning is applied to the entire 1,357 square miles instead of to small fractions thereof, the force of the argument becomes more apparent.

It would appear from the foregoing that the solution of the problem of storage of flood waters is not in the retention of a small percentage of the storm waters behind dams, but in applying storage over the entire watershed by the systematic protection and extension of forest and brush covered areas.

DEVELOPMENT OF POWER ON YUBA RIVER.

Nearly all the ditches and reservoirs in the basin of Yuba River were constructed to furnish water for mining purposes. Upon the rendering of the judgments in the cases of *Woodruff v. The North Bloomfield Mining Company* (18 Fed., 753) and *United States v. North Bloomfield Mining Company*, circuit court of appeals (81 Fed., 243), hydraulic mining was suspended. It has been partially resumed under the "Camanetti Act," passed March 1, 1893, which prescribes that where approved storage of detritus can be secured the operations may proceed under a permit granted by a commission composed of officers of the Corps of Engineers, United States Army, and revocable by said commission should the restraining works prove inefficient.

These restrictions have left a large surplus of water, for which use has been sought in the development of electric power. There is at present more power developed in the Yuba River Basin than upon any other river in California. Some idea may be obtained of the magnitude of these works when it is understood that there are about 1,000 miles of ditches, which cost, including reservoirs and dams, at least \$6,500,000, in addition to which are the power stations, lines, etc., mentioned elsewhere in this report. An interesting feature in the development of water is its successive use. Water from Lake Spaulding and Lake Bowman systems is first used for mining; it is then picked up by the Nevada division of the Bay Counties Power Company and used for power, and immediately falls into the head of the Excelsior Ditch and is used for mining and irrigation at and below Smartsville, falling in this distance from 4,846 feet at Lake Spaulding, or 5,450 feet at Lake Bowman, to 200 feet above tide around Smartsville.

In the diversion of water into and from its own drainage basin Yuba River presents both cases. Water from the South Fork of Feather River is diverted across the divide between it and Yuba River at Woodville, at an elevation of 3,200 feet above tide, and is used in and around Challenge and by the Consolidated York Mining Company. Yuba River water from the South Yuba Water Company's system is diverted into the basin of Bear River, thence into the basin of American River, and some, via the New Blue Point Mining Company's ditch, back into the basin of Yuba River.

EXTRACT FROM REPORT ON IRRIGATION INVESTIGATIONS ON CACHE CREEK.

By J. M. WILSON, C. E.,

Agent and Expert, Irrigation Investigations, Office of Experiment Stations, U. S. Department of Agriculture.

INTRODUCTION.

The district to which the investigations described in this report were directed is the watershed and valley of Cache Creek. It embraces the county of Yolo and parts of Lake and Colusa counties. All of Lake County is mountainous, as is also that part of Colusa County which is drained by Cache Creek. The western boundary of Yolo County is the crest of the eastern ridge of the Coast Range. The eastern slope of this ridge covers about one-third of the county and is of little value agriculturally, except as a stock range. To the east of this mountain region lies a border of low hills; beyond, the great Sacramento Valley, stretching away in an almost unbroken plain, from Suisun Bay on the south to Red Bluff on the north, a distance of about 140 miles. Yolo is the second county north from the bay and lies directly across the river and west from the city of Sacramento.

As with most of the agricultural country west of the Missouri River, the stockman was the first occupant. Pasturage was abundant and continued throughout the year. The mild winters seem to make unnecessary the providing of food for stock as in the more rigorous climate of the East. Following the discovery of gold, in 1848, came the rapid development of the mines and the golden age of California, bringing a ready market for all staple products at remunerative and sometimes fabulous prices. The stockman had every encouragement to expand his herds, but with the winter of 1861-62 came unprecedented floods and disaster. It was estimated that 40 per cent of the cattle in Yolo County perished from the effects of storms, floods, and lack of food. The spring of 1862 was again favorable, and, stimulated by good prices which still prevailed, the cattlemen sought to retrieve their losses. With 1863 came scanty rainfall, to be followed again in 1864 by a drought of unprecedented severity. There was no food for the stock, and it either perished or was sold for a song, to be driven over the mountains into Nevada. The cattlemen were ruined. The reign of the vaquero was over.

In the meantime the agricultural interests were gaining ground, and it had become apparent that the returns from tilling the soil, though more modest, were less precarious than those from stock raising. It had also developed that the soil and climate were particularly adapted to the production of small grains. Prices were good and shipping facilities improving. From experimenting with a few acres in 1849 and 1850 the area cultivated was increased, until in 1860 there were, in round numbers, 39,000 acres seeded, chiefly to wheat and barley. By 1866 the acreage had increased to 87,000. From this time forward the increase was steady, till in 1900 the total area reported under cultivation in wheat and barley alone is 249,848 acres.

Before California became a part of the United States, the lands extending along both sides of Cache Creek from the head of the Capay Valley to Sacramento River had been granted away by the Mexican Government. The Rancho Canada de Capay extended from the head of the valley to near the present site of the town of Madison, a distance of about 8 leagues, and contained 9 square leagues. Below this the Guesisosi or Gordon grant extended for 2 leagues down the stream and contained 2 square leagues. The Rancho Rio Jesus Maria or Hardy grant extended from the east line of the Gordon tract west to the Sacramento and contained 6 square leagues. These grants were subsequently confirmed by the United States Government.

The land laws in force for several years after California became a State favored the acquisition of large bodies of land by single individuals. Advantage was taken of this by the early settlers, many of whom acquired large landed estates, and their extensive holdings have, by keeping the population sparse, been unfavorable to development of the country. * * *

WHEAT GROWING.

The leading agricultural industry of this section is the production of wheat and barley. The wheat and barley are sown during the fall and winter, and grow during the cold months of winter and spring. There is usually rainfall sufficient to mature them. Without irrigation these are practically the only field crops that can be matured. The land has been so long cropped with these grains that the grain-producing elements of the soil are showing signs of exhaustion and the yield has seriously diminished. When prices are favorable, there is something very taking about the methods of the wheat grower of this region. Gang plows drawn by teams of 8 or 10 horses turn the soil. The man with the harrow rides behind on horseback while directing his team. The seeding is done in the same large way. The harvester, drawn by 32 horses or a traction engine, cuts and thrashes and delivers in sacks each day the grain from 20 to 30 acres. The straw is burned. In the spring succeeding the harvest the land is plowed and then lies fallow until the following fall, when it is again seeded. But without irrigation there can be no rotation of crops and no chance for the soil to recuperate. It is a fascinating but destructive system of agriculture, and the farmers of Yolo County are paying the penalty in steadily diminishing crops. Where once the returns were 40 to 60 bushels to the acre the farmer now receives 12 to 30 bushels. This, with the low prices prevailing, has rendered grain farming very unprofitable. Only those who by operating on a large scale secure the full advantage of labor-saving machinery can now make wheat farming profitable. The tendency of all this is to the elimination of the small farmer and an increase in the acreage of the larger landholders.

I would not wish to be understood as advocating the abandonment of grain growing in this section. The natural conditions are here peculiarly favorable for the production of wheat and barley, and their cultivation will always be a leading industry, not only in Yolo County but throughout the whole Sacramento Valley. What I deprecate is the wasteful and destructive system which is impoverishing the land and ruining the farmer. With the rotation of crops, which irrigation would make possible, these lands might soon be restored to their former fertility. A less area in wheat with a larger production would mean success where now is failure.

The small farmer is falling behind, and his lands are gradually passing into the possession of his more prosperous neighbors or into the hands of the trust companies from whom he has borrowed money to keep up the unequal fight. Many once pleasant homes are now deserted and falling into decay, occupied for a few days during each of the seasons of plowing, sowing, and harvesting by a Chinese cook, who prepares the meals for the men who, living in their blankets, are employed temporarily for this work. There can be no healthful social life under such conditions of isolation as the present system entails.

APPROPRIATION LAWS OF CALIFORNIA.

In 1873 the law of appropriation was placed on the statutes of California. It is familiar, and does not need to be reproduced here. The idea of posting a notice in order to fix a right, has its origin in the practice of the miner in locating mineral claims. The miner's notice was posted on the tract claimed, and described its boundaries. It was a sufficient notice to all comers of what was taken. Another miner could, with this before him, fix the boundaries of another claim without risk of interference. It accomplished the purpose for which it was designed. Some California genius, whose name is lost to fame, conceived the idea that a notice posted at the point of diversion would be just as efficient in fixing and defining a claim for water, and so it passed into the statutes, to be copied almost verbatim by nearly every one of the arid States at some stage of their irrigation career. How a notice posted in the tule swamps at the outlet of Clear Lake could be seen and regarded by a citizen of Yolo County 50 miles away is not clear. The statute imposed no restrictions as to the volume that might be appropriated by a single claimant, and as a result each claimed without regard to his own needs or to the prior uses of others. If the United States Government had permitted or authorized settlers upon its unsurveyed lands to each claim everything within the reach of his vision and had allowed the claimants to settle the boundaries of their respective claims by appeal to the local courts, we should have had the same trouble with the land boundaries that we now have with water rights, except for this—that a dispute between A and B as to the location of their land lines and the manner of its adjustment need not necessarily be of any interest to Z, who lives in another county, while the adjustment of A and B's differences over a water right, either by agreement or by the decree of a court, may mean the practical extinguishment of the other rights to the waters of a stream.

The manner of making a record under the law is equally faulty. Instead of bringing together in one place the record of the filings on the same stream, the filings are distributed in the records of the various counties through which a stream or its tributaries flow. In the case under consideration the records of the counties of Yolo, Lake, and Colusa were searched before all the filings could be located.

PRESENT CONDITIONS AND POSSIBILITIES OF YOLO COUNTY.

With the exception of the few pumping plants described, the Moore ditch holds the field. The capacity of the ditch as managed is utterly inadequate to the demands of the territory covered. Except for those who are most favorably situated, there can be no certainty of obtaining water when desired. When water is most needed there are always more wanting it than can possibly be served. The lack of certainty,

or rather the certainty that all can not get water, operates to discourage the growing of crops requiring irrigation. The cost of leveling the land and preparing the levees for flooding, which is almost the universal custom here, is no small item of expense. Unused levees are not only useless but are impediments to cultivation and harvesting. The water user, disappointed in getting water for lands already prepared, has little encouragement to continue or extend his efforts. The more progressive farmers, who are convinced that the growing of grain is impoverishing the soil and who would gladly change to a mixed husbandry with rotation of crops, are still compelled to grow wheat year after year at a loss. With water these lands will produce four to six crops of alfalfa annually, aggregating 5 to 10 tons per acre. With this alfalfa and the other forage crops that would be possible with an assured supply of water, the growing of cattle and sheep, the feeding of range stock, and hog raising would all be profitable industries. The possibilities of this section for dairying have been amply demonstrated by the farmers in the vicinity of Woodland and Yolo. The long season that it is possible to keep stock on green feed in this climate when water can be supplied for the irrigation of the pastures makes the conditions here peculiarly favorable for this and all kindred industries. The only drawback is the lack of water for pasture and for forage crops.

If the history of this "chosen valley" was different from others we might look for the cause of all this dismal failure in the character of the people who have been engaged in these enterprises, but the managers and promoters of these failing ditch enterprises were not weaklings. Their character is approved by their success in other lines before and since. Their fault was a too great faith in a system which was only lack of system, whose pretended regulation only gave fancied security at first to later add to their embarrassment. Everywhere, all over California, wherever there has been enterprise enough to attempt to use the water, the story is the same. The energy and capital of water users and appropriators are consumed in litigation. The cause is not in the people who seek to utilize the water, but in the law regulating the appropriation and use of water.

There is now shipped out of Yolo County annually 50,000 to 80,000 tons of wheat. If the water wasted in Cache Creek was conserved and, as it comes down to water the fields, used in manufacturing this wheat into flour, one-third of this tonnage might be left behind to be used in the production of pork and mutton and beef and dairy products. California is shipping to-day from Chicago and Omaha and Kansas City bacon and lard that she can produce within her own borders as cheaply as they can be placed on the market of the great corn-producing States. The supply of poultry and eggs and butter and cheese which is now shipped into California across half the continent

could be profitably furnished by the home production. She can supply her own people and still have surplus for export in her Pacific trade. There ought to be in Yolo County 50,000 acres in alfalfa, instead of 5,000, and stock enough to consume it.

We have here a country of marvelous possibilities, a soil rich in all the elements of plant growth, with surface smooth and easy of tillage, a climate whose summer heat and winter cold are tempered by the breezes of the Pacific, so equable that here all the choicest products of the temperate zone and of the subtropics are grown alike in perfection. Here flourish side by side the apple, the peach, the pear, the plum, the apricot, and grape, along with the orange, the lemon, the lime, and the fig. Here the oak and the pine, there the palm and the pepper tree. The roses bloom winter and summer. The orange carries its fruit through the winter, the oleander is a tree, and the heliotrope a hardy shrub.

As if to crown her good gifts to this favored country, during the season of harvest and fruitage nature sends a cloudless sky. Grain, ripe for the sickle, may stand uninjured for months waiting the busy harvester. The warmth and light develop rich juices and exquisite coloring of flower and fruit and a wealth of bloom and perfume unknown in the Eastern climate. Without rain the curing of forage is attended with none of the uncertainty and anxiety that attends this work in countries where the rain may come at all seasons. The advantage of a clear sky is especially seen in the preparation of dried fruits. The California dried fruits—the peaches and prunes, apricots and nectarines, and figs—are for the most part dried in the sun. This makes possible the saving of much defective fruit, and affords an outlet for the surplus which can not be canned or shipped or used locally. Indeed, the risks attending this method of dealing with the fruit are so much reduced and the results so satisfactory that many of the larger fruit growers dry nearly all their product. Unlike the fresh fruit, it is not perishable and the risks of shipping are small. California dried fruit is staple, and has a regular quotable value in the markets of the world. * * *

EXTRACT FROM REPORT ON IRRIGATION PROBLEMS IN THE SALINAS VALLEY.

By CHARLES D. MARX, C. E.,

Professor of Civil Engineering, Leland Stanford Junior University.

IRRIGATION PROBLEMS IN THE SALINAS VALLEY.

Irrigation was practiced in the Salinas Valley by the mission fathers as early as 1791, and traces of an old irrigation ditch belonging to the Mission Soledad exist to this day.

This early beginning of irrigation, however, led to no development. With the secularization of the missions in 1833, and their subsequent decay, the disappearance of most of the irrigation works went hand in hand. This was due in a large measure to the fact that California was a grazing and not an agricultural country. The discovery of gold checked for a time the natural transition from the range to the grain farm, and from the latter to diversified farming. In the Salinas Valley the change has certainly been a slow one, and the irrigation development has been correspondingly slow. This is fortunate for the inhabitants of this fertile valley, because they will be able to profit by the mistakes made by the irrigators in other parts of California—that is, if the recommendations made by the engineers who have studied California irrigation conditions are carried out.

The Salinas Valley lies largely in Monterey County, though some of the tributaries of the Salinas River pass through portions of San Luis Obispo and San Benito counties. More than 100 miles in length and from 3 to 15 miles wide, the Salinas Valley slopes slightly from the Gabilan Mountains on the east and the Santa Lucia Mountains on the west to the Salinas River. The river with its tributaries has a total drainage area of 4,940 square miles, divided as follows:

Drainage area of the Salinas River and its tributaries.¹

| Area. | Square Miles. | Area. | Square miles. |
|-----------------------------|---------------|-----------------------|---------------|
| Salinas River, direct | 1,956 | Nacimiento River..... | 394 |
| San Lorenzo River..... | 282 | Estrella River | 1,675 |
| Arroyo Seco River | 291 | | |
| San Antonio River..... | 342 | Total | 4,940 |

The mean annual rainfall at several stations in the valley is given below. The table is made up from records furnished by the chief engineer of the Southern Pacific Railway.

Mean annual rainfall in Salinas Valley.

| Station. | Inches. | Station. | Inches. |
|---|---------|---|---------|
| Pajaro, mean of twenty-seven years.... | 19.24 | San Ardo, mean of fourteen years..... | 10.36 |
| Castroville, mean of twelve years..... | 16.58 | San Miguel, mean of fourteen years.... | 10.22 |
| Salinas, mean of twenty-seven years.... | 13.55 | Pasa Robles, mean of fourteen years.... | 14.89 |
| Soledad, mean of twenty-seven years.... | 8.82 | Templeton, mean of fourteen years | 16.68 |
| King City, mean of fourteen years..... | 10.34 | Santa Margarita, mean of twelve years. | 24.33 |

This rainfall was, until recently, considered sufficient for agriculture. Not many years ago it was written: “It is the absence of droughts which distinguishes the Salinas Valley from other sections of the State where irrigation is required to insure crops.” This view is no longer held. Two successive dry years have seriously injured the cattle

¹ These areas are the actual areas tributary to the Salinas River. In part of it the run-off does not reach the river.

industry, and in many sections of the valley the grain crops, too, have been a failure. In ordinary years the total rainfall is sufficient to produce crops, yet its distribution is such that to insure crops for the future irrigation will have to be resorted to.

The following table shows the monthly mean rainfall at Salinas, as reported by the United States Weather Bureau:

Monthly mean rainfall at Salinas, Cal., 1872-1899.

| Month. | Inches. | Month. | Inches. |
|---------------|---------|----------------|---------|
| January..... | 2.92 | July..... | 0.00 |
| February..... | 2.22 | August..... | .02 |
| March..... | 2.29 | September..... | .16 |
| April..... | 1.20 | October..... | .72 |
| May..... | .45 | November..... | 1.30 |
| June..... | .14 | December..... | 2.52 |

In the twenty-seven years covered by the table no rain has fallen in July, and the rainfall from May to September is hardly appreciable. With such a distribution of rainfall any but the most primitive forms of agriculture are impossible. This fact was recognized by Messrs. Brandenstein and Godchaux, who in 1884 organized the San Bernardo and Salinas Valley Canal and Irrigating Company. The lack of success of this scheme, though attributable to various causes, is in a measure due to the lack of appreciation of the value of irrigation on the part of the farmers. Mr. Brandenstein stated that as a rule men preferred to wait and take their chances on possible rains to the doing of any work which might prove superfluous. The necessity of irrigation, however, is now recognized by the intelligent and progressive farmers of the Salinas Valley, and the waters of the Salinas River and its tributaries will not be allowed to run to waste in the future as in the past. * * *

USE OF UNDERGROUND WATERS.

There are undoubtedly many parts of the valley for which irrigation by pumping from subsurface sources will be more economical than the construction and maintenance of long and large ditch lines, with the resultant large losses of water in transmission. The determination of the existence of such subsurface sources is therefore of great importance, and our investigations were extended in this direction.

Irrigation by pumping is already practiced to some extent in the Salinas Valley, as shown in detail below. As pumping plants increase, a lowering of the subsurface water level will undoubtedly take place, interference of new wells with old ones will result, and lawsuits will follow. There are at present no methods by which a filing on subsurface water can be made, unless an actual stream flowing between banks can be shown to exist. It certainly seems desirable that something

should be done which will protect a man when he has established a pumping plant and secure to him the permanent use of a definite amount of subsurface water. In New Hampshire this rule has been adopted in several decisions: "That a land owner's right to obstruct or divert oozing or percolating water is limited to such a quantity of water as is necessary for the reasonable use of his own land." That ruling raises the difficulty of deciding what constitutes "reasonable use," and in England as well as in most States of the Union, this difficulty has been thought so great by the jurists deciding water cases that they have declared that there is no property in underground water. This whole question is treated in an admirable manner by Lord Robert Cecil, Q. C., in a paper entitled "The law of underground water," published in the *Engineering Record*, December 2, 1899. He says:

The law is clear. It is generally true that all that lies beneath the lands belongs to the owner of the surface. To this rule water is the exception. There is no property in underground water. But, on the other hand, each owner may pump from his land what water he can get, with two exceptions: He must not directly or indirectly take water already *contained* in a surface stream; nor must he abstract water flowing underground in a *known* and *definite* channel. He has a perfect right to drain the supplies to all his neighbor's wells, however long they may have been enjoyed by their owners. So, too, he may pump till springs miles away have ceased to flow and threaten to become swallow holes for the streams they used to feed. Further than this he may not go. Once water is in the channel of a stream above or underground it is safe from subterranean depredators.

This is, Lord Cecil believes, the law: "Whether it should be changed, and, if so, how, is another story." The California decisions agree with the law as laid down above. (*Gould v. Eaton*, 111 Cal., 639; *Hanson v. McCue*, 42 Cal., 303; *So. Pac. R. R. Co. v. Dufour*, 95 Cal., 615; *Vine-land Irr. Dist. v. Azusa Irr. Co.*, 126 Cal., 486.) There exists, therefore, to-day no legal protection for a man who has developed a subsurface supply. * * *

EXTRACT FROM REPORT ON IRRIGATION FROM THE SAN JOAQUIN RIVER.

By FRANK SOULÉ,

Professor of Civil Engineering, University of California.

A BRIEF HISTORY OF THE DEVELOPMENT OF IRRIGATION IN CALIFORNIA AND IN THE SAN JOAQUIN VALLEY.

The problems to be discussed in this paper are those relating to irrigation from San Joaquin River and its tributaries. It seems best before turning directly to them to give a brief history of the development of irrigation in California, and also more particularly in the San Joaquin Valley.

California, at first possessed by Spain, and afterwards by Mexico, derived its earliest ideas and methods of irrigation from those countries. The first irrigation in the State was practiced by the Spanish mission fathers who, while converting to Christianity and civilizing the Indians, planted and cultivated vineyards, orchards, and farms surrounding the missions. The methods of irrigation in Spain were particularly applicable to the coast region and interior valleys of California because of the similarity of the natural conditions in the two countries.

Until the coming of the Americans the water laws of California were those of Mexico and Spain. Under them the waters of the stream were held to be a public trust, title to which could not be granted by any private person or corporation. Permission for use only could be given, and then to the actual user, and to the amount used. Upon the discovery of gold in California in 1848, the miners took water from the streams to wash the golden sands, and established local laws, dictated by common sense and the interests of their industry. As indicating their righteousness, it may be said that they were practically the same in all mining districts, however widely separated.

As time went on, California, which had been at first almost exclusively a mining State, became a great agricultural one. Its valleys and hill slopes produced immense quantities of wheat and other cereals, and spots favored by nature were converted into wonderfully productive orchards and vineyards. Wherever within her boundaries the rainfall was ample and reliable crops were good, both in quality and quantity; but in many localities, where the soil and sun were friendly, the rainfall was uncertain and often deficient. Settlers in many cases realized the importance, and often the absolute necessity, of the artificial use of water upon their farms in order to secure crops and a livelihood.

The first attempts of the American farmer at irrigation resulted in works of the most primitive character. Often individual effort led to the introduction upon the land, through a plow furrow, of a small quantity of water from a neighboring stream. Later, communities of farmers cooperated and constructed irrigation canals to be utilized in common. At first, of course, the water most readily obtained was made use of, and for a time only small, cheap systems were constructed and elementary irrigation practiced.

As districts became more populous and the necessity for water greater, individual effort and even local cooperation became insufficient, both as to methods and capital, to supply the demand for water, and more costly and complicated irrigation systems were found to be necessary. Consequently, stock companies were formed and large amounts of capital enlisted in irrigation enterprises. In this way most of the waters flowing into the streams were "taken up" or "appropriated,"

and the importance of storage of the flood waters to meet the growing need became evident.

The development of stock companies and corporations soon grew to such proportions that a new danger became apparent. A monopoly of the waters available for irrigation was threatened. Great systems involving the expenditure of hundreds of thousands of dollars, or even millions, were practically absorbing all sources of water for irrigation. The farmers found themselves at the mercy of water companies, both as to rates charged and quantities of water supplied, and the life and growth of agricultural communities were considered in jeopardy. This condition of affairs resulted in the evolution of the Wright irrigation law.

This law seeks to establish a system by which the people of any locality, the lands of which are capable of irrigation from a common source, may form an irrigation district on a basis somewhat similar to that of a corporation. The effects of this law on irrigation in California, and the litigation arising under it, will be discussed later on.

During all this time the advantage of irrigation was becoming more firmly impressed upon California farmers and orchardists. With numerous excellent object lessons before them, they abandoned their prejudices formerly held against it and the expense and labor it involves, and have come to recognize in it an assurance not only of the certainty of a crop but of vastly increased production from the same fields and, perhaps, of several harvests in a single year. As a result, from the more arid districts of southern California, where it naturally began, irrigation has spread rapidly over the State to its northern boundaries, and even over localities which are credited with reasonable rainfall.

Following closely in the path of such enterprise has come a wonderful increase in the variety and yields of crops, in population and wealth. Raisins, wines, citrus and other fruits have supplanted pastures, wheat, and barley; cities and towns stand on the ground of the old lonely farmhouse, and millions in bank are substituted for the "promise to pay" of unfortunate farmers. As an example of this wonderful increase in population I will mention only seven of the many counties practicing irrigation, viz: Los Angeles, San Diego, San Bernardino, Kern, Tulare, Fresno, and Merced. In 1870 their total population was 40,849, and their combined wealth \$22,513,820. In 1890 their population had increased to 296,719, and their wealth to \$198,356,127, or the population had multiplied more than sevenfold and the wealth ninefold.

In contrast to these improved districts are those which have persistently resisted irrigation. They have not advanced. Often they have gone backward, and have retrograded in population and in wealth.

* * *

DISTRIBUTION OF WATER AMONG CANALS.

The waters of San Joaquin River are divided among the several canals, not by mutual agreement among the owners, or by direction and control of any board having authority, or any State official, but simply by being taken under the law prescribing the manner and method of appropriating waters for irrigation or other useful purposes.

No report of the progress of the proposed works nor of their completion is made or required subsequent to the time of recording the appropriation, nor of use of the water claimed at any time. The facts in the case must be ascertained, if at all, by private investigation. The difficulty of obtaining such information can not be appreciated except by one having made the attempt. This data is readily obtained from canal companies in actual operation, in as far as possessed by them, but is out of sight and out of reach in the many cases where records of appropriation have been made but the water not used.

The law places no limit upon the quantity of water which may be claimed in this manner. The statutes prescribing the method of appropriation lead to the condition of "first come, first served;" but this is tempered by the necessity of actual use for some beneficial purpose, and also by the vested rights of riparian owners.

The Chowchilla Canal, owned by the California Pastoral and Agricultural Company, has made no filing, but claims its rights by virtue of use since 1872. The maximum intake of the Chowchilla Canal is 120 cubic feet per second. With this exception, all the canals and companies previously described base their claims for water from the streams enumerated upon claims filed, and, in some instances, upon riparian rights also.

No record of appropriation of water for the Aliso Canal has been discovered by the writer, and its claim is probably based upon the riparian rights of its owners, Miller & Lux.

The Blyth Canal has claimed for its use 1,000 cubic feet (per second?) under a 4-inch pressure. Its maximum intake is 400 cubic feet per second.

The Eastside Canal Company claims 345,000 miners' inches under a 4-inch pressure, or 6,900 cubic feet per second. The maximum intake of the canal, claimed for it by its president, is 200 cubic feet per second.

The James Canal Company (formerly known as the Enterprise Canal and Land Company) claims 500,000 miners' inches, under a 4-inch pressure, or 10,000 cubic feet per second. The maximum flow claimed for this canal is 200 cubic feet per second.

The San Joaquin and Kings River Canal and Irrigation Company for its several canals claims from San Joaquin River and Fresno Slough, near the junction of the two streams, an aggregate of 165,000 miners' inches under a 4-inch pressure, or 3,300 cubic feet per second; and in addition to this quantity "all the water in the river at Fire-

baugh." The maximum intake claimed for their canal is 1,400 cubic feet per second. In addition to these filings, Miller & Lux claim their rights as riparian owners to an amount as yet indefinite and unadjudicated. They also use the waste and seepage waters from these canals and the flood waters of the river to fill Poso and Temple sloughs and Santo Rita Canal for the irrigation of their own ranches in that district; and to flood their wild-grass lands adjacent thereto.

The maximum intake of all these canals, with the exception of the latter group belonging to Miller & Lux, amounts to 2,460 cubic feet per second; so that we see that on this river, whose mean delivery, according to the recorded gagings of it, is 2,448 cubic feet per second, we have claims made by the owners of canals now in operation aggregating 21,320 cubic feet per second, plus "all the water in the river at Firebaugh," plus the riparian rights claimed by Miller & Lutz, plus the flood waters claimed for their ranches.

We see from this comparison that the mean flow of the river has apparently been reached by the actual consumption on the part of existing canals, and that the claims to water by the companies in actual operation are nearly ten times the amount of the mean flow. Evidently the irrigated area in this part of the State may be extended only by more skillful and economical use of the waters now available and by extensive storage in the seasons of flood flow. The unfortunate lack in this State of a board of water administration, together with the existing loose laws relating to appropriations, naturally leads to such a condition of affairs as that above described and to ever recurring litigation.

The Madera Canal and Irrigation Company is the only one taking water from the Fresno. According to the records of Fresno and Madera counties it has filed on a total of 408,000 miners' inches, or 8,160 cubic feet of water per second. Of this quantity 6,000 miners' inches are claimed from Big Creek and 10,000 miners' inches from Raynor Creek, a natural tributary of Merced River. The flow of the river, as has been shown, at its greatest mean monthly discharge is 1,632 cubic feet per second, so that the amount claimed from this stream and its tributaries is five times the greatest mean monthly flow, and nearly forty-ninetimes its annual mean flow of 167 cubic feet per second. The company claims a maximum intake for its canal of 800 cubic feet per second.

The Sierra Vista Vineyard Company has claimed, by record, from the waters of Chowchilla Creek, 24,000 miners' inches, or 480 cubic feet per second.

The waters claimed by George D. Bliss and George D. Bliss, jr., for their dams and canals on Chowchilla Creek, below the Sierra Vista Vineyard Company, are 5,000 miners' inches, plus the water rights of their predecessors, J. M. Montgomery, a record of whose claims the writer has been unable to discover.

DISTRIBUTION OF WATER AMONG IRRIGATORS.

In no one of the systems described is the water measured, but when sold is dealt out by the superintendent of the canal in amount sufficient to satisfy the irrigator, who is charged so much per acre irrigated. Both the company selling the water and the farmer buying it admit that the water would be used more wisely and economically if sold by measure, but each party to the contract objects to the measurement of water—the company on the ground that the measurement would take too much time and trouble, and the irrigator because he feels that he would not be treated as liberally as at present. The writer does not doubt that the sale of water by measurement would lead to a greatly improved system of conducting the water to the lands and applying it to them, as well as to much more skillful and economical use of it, and would undoubtedly greatly increase the duty of water in this district.

The water of the Eastside Canal is almost exclusively used upon the Stevenson and Mitchell lands at its extremity. A small quantity is sold to farmers in the vicinity. Each farmer draws off the quantity that he believes his fields need, and pays for it in cash, the charge being \$2 per acre irrigated, or \$2.50 if the water is not contracted for before January 1. The canals and gates are under the control of a superintendent, but all small irrigating ditches must be constructed by the farmers at their own expense.

The San Joaquin and Kings River Canal and Irrigation Company sells its waters to whoever wishes to purchase them. The public water rates of the company for the year of 1900 are as follows: For any part or all the season between July 1 and the following June 30—for alfalfa, \$2.50 per acre; for cereals and corn, \$2 per acre; for orchards and vineyards, \$2.50 per acre; for market gardens, \$5 per acre. For water supplied between July 1 and September 1, for second crops of any kind, except alfalfa, \$1 per acre. Lower rates than these have been established in Stanislaus County by the board of supervisors, but their authority in this respect is now being contested in the courts by the company.

The irrigation water from the San Joaquin and Kings River Canal and Irrigation Company is supplied upon the written request of the irrigator and under the supervision of the canal superintendent, and is sold at so much per acre, the quantity supplied being sufficient to satisfy the irrigator.

The sale of water by the Madera Canal and Irrigation Company is conducted differently from that of the others. Water rights are sold to subscribers, or stockholders, at \$5 per acre. The owners of these rights then pay \$1 per acre per year for the use of the water. Non-stockholders pay \$1 per acre for the first irrigation of their land and \$1.50 per acre for each subsequent irrigation. These latter rates for

nonstockholders were ordered by the Madera County board of supervisors in 1898. A large number of nonstockholders, owning about 6,000 acres of land, take water at stockholders' rates as before stated, by virtue of the purchase, originally, of their land with water as an appurtenance thereto. This form of contract just described, for water, is not satisfactory, either to holders of water rights or to ordinary irrigators. The former complain of their obligation to pay \$5 per acre for each acre which they at first contracted to irrigate, whether afterwards they wished to irrigate it or not, and also that the nonstockholders have been given better terms than they. The nonstockholders complain of a continued deficiency in the water supply.

The James Canal Company leases much of its land to farmers, who divide the water among themselves, according to their needs, and pay for the use of the land and water with one-fourth of the crop which they produce. The water sold is not measured in any way.

The form of contract which seems most satisfactory to irrigators in the section of the State visited by the writer is the one which stipulates that upon notice being given to the canal company the latter will furnish the required amount of water upon being paid therefor at so much per acre. Other forms of contract, more stringent in their exactions on the part of the canal companies, are decidedly unpopular, and in some cases have the effect of preventing irrigation. * * *

EXTRACT FROM REPORT ON WATER APPROPRIATIONS FROM KINGS RIVER.

By C. E. GRUNSKY,
City Engineer, San Francisco, Cal.

KINGS RIVER.

There is probably no river draining the western slope of the Sierra Nevada whose irrigation system is more worthy of careful consideration than Kings River.

Physical conditions are favorable for the diversion of the river water upon the great eastern plain of the San Joaquin Valley. To the right and to the left the lands commanded are fertile and smooth surfaced, well adapted to irrigation, and of great extent. The river has a large discharge, particularly in the months when water is most in demand for irrigation. The early settlers on the banks of the river and in the river delta were appreciative of the advantages resulting from the use of water for irrigation, and the efforts to extend the irrigation system have been persistent and more than ordinarily successful.

It goes without saying that the results would have been still better, and that much less litigation relating to water titles would now be

pending, if operations could have been conducted under adequate and equitable water laws.

Under the somewhat doubtful sanction of law, and in direct contravention of the riparian doctrine as sometimes interpreted, water has heretofore been taken, and is being taken, for use in irrigating lands not riparian, by anyone in need thereof or in a position to take advantage of opportunities and for the supply of his own needs and of those of his neighbors. A lamentable absence of recorded facts in the matter of the claiming and the taking of water and the putting of the same to some beneficial use not only renders a study and discussion of water rights and water appropriations difficult and almost impossible without an elaborate and extended inquiry into physical facts and conditions, but, coupled with the uncertainty of being able or permitted to acquire any permanent rights to its use and to receive adequate protection therein, has discouraged all except a few bold and favored ones from putting forth special efforts or taking any considerable financial risks looking toward development and control of water for irrigation purposes. So it happens that but few of the Kings River canals are managed for profit from the sale of water. Most of them are owned by the land owners.

It was perhaps fortunate for the region now watered by Kings River that the first comers thought the high plains of the valley fit for general agricultural purposes, and particularly for wheat raising, without irrigation, because these settlers, contrasting their crops with the luxuriant growth upon the river bottoms, could not but appreciate the contrast, due mainly to the presence of abundant moisture. And when crop failure after crop failure made financial ruin seem certain there remained nothing to do but to risk all in an endeavor to get water out upon the upland.

So it came about that many were soon ready to make desperate efforts to coax a portion of the river's abundant supply of water out upon the high, dry plain, for when a first effort had met with success, and apparently justified the judgment of its promoters, others quickly followed, and this despite the fact that under some interpretations of the riparian doctrine no such diversion was permissible, unless, possibly, for riparian lands, without the consent of all lower riparian owners. Whenever the settlers were financially able and water was within reach of their means, even though the means consisted not of coin, but only of plows, scrapers, and willing hands, ditches and canals were constructed. It was thus that Mr. M. J. Church, the projector of the Fresno Canal, and himself the owner of a section of upland, pledged his whole credit to promote ditch construction. And it was the same spirit which a few years later prompted the farmers of the Kingsburg region to pay for their right to take water from the Fresno Canal by constructing one of its most expensive sections, contributing labor,

horses, implements, and supplies, at a time when they were hard pressed in obtaining the mere necessities of life. It is this spirit which has called into being the extensive irrigation canal and ditch systems of Kings River, which now command over 1,000 square miles of valley land and actually benefit an area of about 70,000 acres.

Kings River takes rank among the large rivers which drain the western slope of the Sierra Nevada. Only one of these has a larger drainage basin—Kern River, with 2,345 square miles; but the precipitation on the watershed of Kern River being less than that of the Kings River, the latter outranks the former when volumes of flow are compared. San Joaquin and Tuolumne rivers are in this class, with drainage basins but little smaller than that of Kings River, but both being farther north with somewhat greater rainfall. In location Kings River may be classed as fairly central. It cuts across the east-side plain of the San Joaquin Valley to the Tulare Lake, about midway between Stockton and the southern extremity of the valley. It is paralleled by the San Joaquin River on the north, about 20 miles distant, and by the Keweah River on the south, about 15 miles away. The breadth of the east-side valley-plain course of the river from the base of the foothills to the lake and swamp region is about 30 miles.

The elevation of the valley where Kings River leaves the foothills is about 400 feet above sea level. It falls in 20 miles to about 300 feet at Fresno and about 86 feet thence to Summit Lake, which, as its name implies, lies on the delta summit which divides the Tulare Lake basin from the Fresno swamp region to the northward. This delta summit is a very flat ridge built across the valley by the detrital matter brought down by Kings River waters. At its lowest points in the trough of the San Joaquin Valley its elevation is about 214 feet above sea level, and about 30 feet higher than the general level of the lowest portions of the Tulare Lake bed.

WATERSHED.

The watershed of Kings River has an area of 1,742 square miles. It is fan-shaped in form, spreading out as it extends northwesterly from the foothills near Sanger into the Sierra Nevada, of whose crest line the river drains a length of about 45 miles, extending from Mount Goddard on the north to Mount Silliman and Mount Brewer on the south. Much of this drainage basin is in the rugged, bare, granite region, at an average elevation of about 5,000 to 7,000 feet. The stream and its branches flow in deep, rocky gorges of stupendous grandeur, and the perpetual snow hangs on the shaded slopes of the highest mountains, some of which rise to heights of 12,000 to 14,000 feet. Very little of the river's mountain drainage basin is habitable. Probably more than three-fourths of it is accessible for four to five months only each year. Precipitation on this watershed increases

from the base of the Sierra Nevada to near the mountain summit. The average annual fall of rain and snow for the drainage basin of the river is about 25 inches. * * *

WATER-RIGHT LITIGATION.

A search of the court records of the three counties through which Kings River flows has been made, and abstracts of a number of cases, showing the basis of complaint, the answer, and the decree of the court (if judgment has been rendered) are noted in the abstracts, which are herewith presented.¹ The abstracts cover 42 cases in Fresno County, 42 cases in Tulare County, and 19 cases in Kings County, and these by no means represent all the litigation relating to water and water rights, but cover only the principal cases in which the rights of ditches and canals to divert water from the river, or its branches, are brought into question. The list could be supplemented with many more relating to controversies between water consumers and the canal companies which are furnishing the water, and others relating to the validity of the formation of irrigation districts and kindred matters. Time and means have not permitted this inquiry to be made complete.

When the lands bordering upon Kings River in its course from the foothills to the valley trough were sold there was doubt as to whether the riparian doctrine prevailed in this State, and even after being recognized by the courts, this doctrine, by reason of the vagueness and uncertainty of the definition of the rights of the riparian owner and of the extent of riparian lands (particularly when the riparian owner himself often claims under this doctrine merely to become an appropriator), was but little heeded when the matter of making a water appropriation was under consideration. In view of the abundance of the water supply, the earliest ditch builders felt secure under the sanction of custom and the language of the statute which permitted the taking of water for beneficial purposes. They preferred to rely upon the fact of the taking rather than upon official records to establish a claim, or a right to the use of water, as against other takers, or often against riparian owners. The demand for better and clearly defined regulations in the matter of acquiring the right to use water has not, therefore, been as urgently pressed as circumstances would seem to warrant. This has no doubt been also largely due to the fact that appropriators themselves have often preferred to first let sufficient time elapse for the perfection of their own works with extensions and increased beneficial use before inviting thorough judicial inquiry and equitable apportionment.

In the upper portions of the valley section of Kings River it flows through the Centerville bottoms in a network of channels, and all the lands bordering the river appear, under the riparian doctrine, to have

¹ The abstracts referred to cover 130 pages of typewritten matter and are too long for insertion here.

some rights that were encroached upon by the canals and ditches taking water from points above or near the upper end of the bottom lands. So, too, the lands bordering upon the delta channels, and, in fact, most of the lands of the river delta, notably the Laguna de Tache Rancho and the large holdings along the southerly bank of the main stream, have, under this doctrine, been in a position to interpose legal objections and obstacles, with more or less success, to the taking of water by the canals. It has not always been a question of compelling the canal companies to pay for the damage done by the diverting of water, but the controversies have almost invariably been in the nature of attempts to estop the taking entirely. Proceedings to accomplish this are often postponed until long after the canal is constructed and in service. The enforcement of a decree is then often thought to be an unbearable hardship, and there are canals on the river to-day apparently evading decrees of the courts which deny them the right to take water.

As a result of the suits brought by the owners of the Laguna de Tache Rancho, who control in the aggregate over 60,000 acres of land in one body, which lies for the most part in the delta region of the river, it was, on July 21, 1885, decreed that the Fowler Switch Canal Company should take no water from Kings River and should fill in the head of their canal. On September 12, 1885, judgment was entered against the Centerville and Kingsburg Canal Company decreeing that their canal take no water, remove all dams and other obstructions from Kings River, and fill in the head of their canal. It was decreed, on November 5, 1885, that the Kings River and Fresno Canal Company should take no water from the river and should fill in the head of their ditch. This decree may have, in part at least, been the reason for the passing of this canal into the hands of the Fresno Canal and Irrigation Company, now controlled by the same persons who own the Laguna de Tache Rancho. A similar judgment was entered against the 76 Canal, or Alta Irrigation District Canal, on November 4, 1889, except as to water for use on the riparian lands irrigated by it in Fresno County. All these decrees, having been affirmed by the supreme court of the State, appear as final judgments. When we still find these canals receiving water at mean to high stages of the river, it may be inferred that they can do so on tolerance.

It would seem more logical and more equitable to have laws so administered that either these canals could never have been built or that, having been built, their rights to surplus water should have been more clearly defined. Here follows abstract of some forty decisions. These decisions do not represent all the litigation between the appropriators of water from Kings River, as numerous cases were of minor importance, or decisions were reversed, or had no bearing upon the right of the canals to water, or are still pending.

A lack of consistency in these court decrees is apparent. In cases where appropriators of water have not acquired rights by the statute of limitations the riparian owners seem to be successful in obtaining decrees restraining appropriators from diverting the waters of the stream, even when the riparian owners are themselves diverting the water from natural channels in order to make it accomplish a greater duty in watering crops than it could accomplish if left to flow undisturbed in natural channels. But after decrees are entered and confirmed, enjoining canal owners from taking water, they are followed by other decrees apparently conceding water to the same canals and fixing the priority of use as between the several canals.

These decisions are rendered at the close of long and expensive trials. The facts relating to canal construction, to canal dimensions and capacity, and to periodical enlargements are not of record, and the courts are not provided with impartial technical aid to ascertain or verify facts which are presented by the host of witnesses marshaled by plaintiff and defendant. Even the experts do not agree, and in many cases the best expert testimony is outweighed by evidence erroneously classed as expert. The expert, moreover, is generally not called until the cause of action has been clearly defined and he must deal with facts as he then finds them; he is rarely in a position to follow up the full history of canal building so as to present a correct sequence of such facts as are essential in passing upon the merits of rival claims to water. * * *

EXTRACT FROM REPORT ON A STUDY OF WATER RIGHTS ON THE LOS ANGELES RIVER, CALIFORNIA.

By EDWARD M. BOGGS, C. E.,
Consulting Engineer, Los Angeles, Cal.

DISCOVERY AND COLONIZATION.

Nearly four centuries ago, when the adventurous explorers of the unknown Pacific Ocean, following the shore of California, touched at various points, they found the land inhabited by savages. More than two hundred years later, when the Spanish missionaries, advancing along the coast, established the outpost of European civilization in California, they found the same race of people living in the same barbarous condition. Unlike the native races which dwelt in parts of New Mexico and Arizona, the Indian tribes of this region possessed no knowledge of the art of irrigation. Without irrigation agriculture was impracticable; consequently progress toward civilization was impossible and the inhabitants remained in hopeless barbarism.

The usual Spanish method of colonization was followed in the set-

tlement of California. This plan which had been successful in Mexico and Lower California embraced three classes of communities—missions, presidios, and pueblos.

The first was due to the zealous efforts of the Spanish missionaries for the propagation of the Christian faith among savage inhabitants of the region. Beginning at San Diego in 1769, a chain of missions extending to San Francisco was founded. This line comprised eleven establishments, spaced some 15 to 25 leagues apart, and usually situated on or near the coast. A second line parallel to the first, but at a convenient distance farther inland, was planned, and some of these missions were built at a later period. The missionaries undertook to minister to the temporal needs as well as the spiritual welfare of their converts. They clothed and fed them, taught them how to labor intelligently on the farms, to build comfortable dwellings, and introduced among them various kinds of domestic animals. Under their direction was begun the practice of irrigation, destined in future generations to become the most potent factor in the permanent development of California.

Each mission was provided with a small guard of soldiers for protection against possible uprisings of the natives. To serve as supports or rallying points in times of great danger from this source, and also as means of defense against attacks from jealous foreign nations, four presidios or military posts were interspersed along the line of missions. Garrisons were long maintained at these posts, and there were located the seats of government of the province, which for many years was of a military form.

Progress in the new province was necessarily slow; all things seemed to conspire against the success of the undertakings. The natural difficulties to be surmounted were great; the division of authority between ecclesiastic and military officers was not conducive to the best results; communication with the vice-regal government in Mexico was slow and uncertain; costly errors were made; disastrous delays were suffered. Nevertheless the missions were gradually extended and each establishment grew in wealth and influence.

Meanwhile both missions and presidios were a heavy financial drain upon the Government in Mexico. The mission farms had been successful from the outset, but they were hardly able to keep pace with the increased demands rising from the growing numbers of neophytes and other dependents of the missions themselves. Consequently they were able to do nothing toward the support of the presidios. Supplies of grain and other necessities for the garrison had to be imported at great cost and with serious delays from Mexico. The expense and inconvenience of this arrangement caused instructions to be sent to the governor to hasten the founding of the third class of settlements—the pueblos or towns.

The pueblos were to have civil governments, practically independent of control of either clerical or military authority, although entitled to the aid and comfort of both. They were to devote their energies to the development of the material resources of the region, especially in agriculture, even then recognized as the only permanent foundation for a civilized government. Thus their establishment was properly regarded as the principal step toward the colonization of the wilderness and the real advancement of the new province. As early as 1776 two sites notably suitable for pueblos were selected. One, on the Santa Clara River, in the north, now the modern city of San Jose, was settled before the close of that year. Numerous delays prevented the occupation of the second chosen site, that on the Rio de Porciuncula, in the south, and it was not until September 4, 1781, that the pueblo named Nuestra Señora la Reina de los Angeles (Our Lady the Queen of the Angels) was founded. The pueblo has become the flourishing city of Los Angeles; the Rio de Porciuncula is now known as Los Angeles River; but on this date began the history of water rights on the stream and the chain of private title to lands within the limits of the pueblo.

The original population of the pueblo of Los Angeles consisted of 12 settlers and their families, 46 persons in all. They were gathered in the older provinces and were induced to come here under the especial patronage of the Government. They were to be supplied at the beginning with live stock, seed, and farming implements, which advances were to be repaid from the products of the land. They were to receive stated sums annually for five years, to be paid them in clothing and other necessities. Each settler was to be granted a house lot and a tract of farming land, and, in addition, all were to enjoy as a community the use of Government land for pasture and for obtaining supplies of wood and water. They were also to be free from taxes for five years.

IRRIGATION IN THE PUEBLO.

The subject of irrigation was given prominent place in the governmental order which directed the establishment of the pueblo. The site was to be chosen with particular reference to irrigation necessities, and the point for diverting the water of the river which would serve the greatest area of land was to be indicated. Many references to irrigation exist in the earlier ordinances and official correspondence, some of which, it is claimed, tend to support the theory that it was the intention of the Spanish Government to grant to the pueblo the absolute and exclusive ownership of all the water of Los Angeles River. It is also asserted that up to the beginning of American domination in California the municipal authorities had exercised full control over the diversion and distribution of water from the river, and, furthermore, that the present city, as the successor of the old pueblo, is

entitled to all the rights and privileges granted to or acquired by the latter. American supremacy brought the old English common law of riparian rights. The conflict which naturally ensued between claimants under that doctrine and those asserting the ancient pueblo right has produced much of the most extensive water litigation of the county. The cases involving the question will be referred to in detail hereinafter. The history of colonization of the region has been given at some length here as being explanatory of the peculiar rights claimed by succession to the pueblos.

LOS ANGELES RIVER.

Compared with prominent streams of the humid region, the Los Angeles River would seem of insignificant size, but by comparison with those of the arid region its importance is apparent. Its waters maintain the existence of the metropolis of southern California, the second city in size and importance on the Pacific coast, besides watering a large area of rich farming land in and around the city. The antiquity and peculiar nature of its water rights give it an especial interest.

Hydrographically the Los Angeles River is a remarkable stream. It rises in the southern edge of the San Fernando Valley a few miles above the city of Los Angeles. Its watershed embraces an area of about 500 square miles, ranging from precipitous mountains to smooth and gently sloping plain. The unusual topography of the basin produces a stream of considerable volume and exceptional regularity of flow. It is to these features that the original selection of the site of the pueblo and the permanence of the modern city are due. About 85 square miles additional area of watershed contribute something to the flow of the river at points below the outlet of the San Fernando Valley.

The total area of 500 square miles is composed of about 175 square miles of high mountains, 135 square miles of lower mountains; the remainder is plain. The first division contains peaks which rise to heights of 6,000 feet or more. The area is well exposed to the moisture-laden winds from the Pacific Ocean, its precipitation is comparatively heavy, its surface slopes are steep, and the run-off is rapid. The second averages much lower in altitude than the first and receives correspondingly less rainfall. The plain area, owing to its partially sheltered exposure, receives less rainfall than even its low altitude would seem to entitle it to. But, on the other hand, by reason of the light slope of the surface of the plain and the open nature of the soil, practically none of the rain falling on this area is lost by run-off.

It is only at times of unusual floods that a continuous stream extends from any one of the mountain tributaries to Los Angeles River. At all other times the mountain torrents discharge their waters upon

the broad, flat plain of the valley, into which they sink and are lost to view. Pursuing their way south toward the ocean, these underground waters are intercepted by the Cahuenga Mountains, an uplifted range which projects like a great wing dam across the south side of the San Fernando Valley, almost effecting a junction with the Verdugo Range on the east. The remaining gap, about 1 mile in width, is the only apparent outlet for the drainage of the entire watershed of 500 square miles. The greatly contracted width of the valley at the outlet naturally results in the rise of a considerable part of the ground water, and the flow thus brought to the surface forms Los Angeles River.

The San Fernando plain extends some 12 miles north and south by 25 miles east and west, covering an area of about 185 square miles. It rises gently from elevations of 500 to 700 feet along its southern edge to heights of 1,100 or 1,200 feet along its northern border. Generally speaking, the soil of the valley is of excellent quality, but here and there are seen the scars left by occasional torrents from the surrounding mountains. Below the surface soil the bed of the valley is composed of *débris* and detritus washed down from the surrounding mountains. The thickness of this deposit is undetermined, but there is every reason to believe that it is of enormous extent. Many wells have penetrated to depths of several hundred feet without striking bed rock, one of them reaching to about 60 feet below sea level. The sands and gravels filling this vast basin perform the office of a great storage reservoir, conserving the otherwise wasted water of rainy seasons and equalizing the flow not only throughout the year but from year to year.

CLAIMS TO WATER ON LOS ANGELES RIVER.

In California all documents relating to titles to water rights, like those affecting real estate, are entered of record in the office of the county recorder of the county in which the property is situated. An attempt to ascertain the status of water rights along Los Angeles River disclosed some interesting but unsatisfactory conditions of the public records in this county. Prior to August, 1888, water rights were embraced in miscellaneous records, which term seems to have included almost everything except deeds. It is found that there are seventy-nine volumes of these miscellaneous records, whose contents are indexed alphabetically by names of persons in five indexes. Detailed search of the indexes discloses the fact that entries of water rights were made in only ten of the seventy-nine volumes. These ten volumes contain 1,147 water notices, which are intermingled with all sorts of miscellaneous records.

Since August, 1888, separate books have been devoted exclusively to records of water claims. Of these there are to this date five volumes and one index, covering 1,420 pages, containing 2,727 entries.

The magnitude of the task of examining the rights existing on any

one stream will be appreciated when it is known that in keeping water records in this State no effort has been made to segregate them according to the different streams in the county, to classify the claims according to the intended use of the water, or to distinguish among the different classes of documents which may relate to the one subject of water. Anything in writing offered for record is forthwith copied into the already voluminous records of the county in chronological order of filing. The only classification is the alphabetical index of names signed thereto. Notices of appropriation are naturally the most numerous, and these are simply placed on record without regard to locality or the use for which the water is claimed. No question as to the existence of prior rights to the same water, the good faith of the claimant, or the legal sufficiency of the form of notice is raised at any time or in any manner. Unquestionably the records of Los Angeles County are encumbered with enormous masses of worthless claims to water, and this condition is constantly growing worse. The crowding already noticeable in the recorder's office is some criterion of what the congestion will be in future years.

For the purpose of this study of Los Angeles River, the writer has examined each one of the 3,874 documents relating to water which appear of record in this county. A great many of the claims give no clue to their locality; others describe it so indirectly or so imperfectly as to require a prohibitory amount of time to ascertain from other sources what stream is affected thereby. The number of claims which clearly relate to the main body of the river is small. This is owing, probably, to the exclusive right claimed by the city. Large numbers of claims have been made to the water of the several tributaries or streams existing higher in the same watershed. These have been claimed in detail many times over, and much greater service has been expected from them than they are capable of supplying, at least under the present conditions.

The earliest recorded water claim in Los Angeles County bears date July 16, 1864, although it is well known that water was extensively used for irrigation more than eighty years before that date. It should be added, however, that there exists in the archives of both county and city a number of manuscript books in the Spanish language which contain miscellaneous documents antedating American occupation. These books have not been examined. They may contain records of water rights, but it is doubtful whether at that early period much attention was given to documentary records of this character. The open and notorious use of water was doubtless considered to be all that was necessary to perfect and to preserve a water right, and there are probably not a few old and well-recognized water rights in this county in force at the present time of which there is no record whatever, except possibly where mentioned incidentally in transfers of real estate. As it is, many of the earliest records of claims were evidently afterthoughts,

as they refer to the long and continuous use of the water, or claim that the use began on a given date many years before.

In these records water is claimed for every conceivable purpose to which it could be applied. The predominating use stated in the notices has been changed from time to time. In the early days of the records mining was the principal use for which water was wanted. At a later period agricultural and stock uses were those most commonly specified. During "boom" times irrigation and municipal supply were almost invariably named, while at one time in recent years there was a widespread epidemic of schemes for utilizing water power to generate electricity for transmission to the surrounding centers of population. Usually the notices of each period embraced not only the uses popular at that time but also those of all preceding eras.

The wording of recorded claims shows how the estimation placed upon the importance of documentary record has changed from time to time. At the beginning and for a number of years the belief seems to have prevailed that actual use was the sole requisite for a title to water. This idea was not far wrong, for the supreme court of this State, in the case of *Waterson v. Saldunbehere* (101 Cal., 107), has decided that where there has been an actual appropriation and use of water, a right to it is acquired regardless of compliance with the provisions of the civil code for the acquisition of water rights. Later, as the population increased and the inadequacy of the water supply to meet all demands became evident, many water users awoke to the desirability of placing upon the official records of the county written statements of their existing rights in order to protect their interests in the future. Thus it was that many of the earlier claims filed for record, being statements of established rights, endeavor to date back to an earlier period. In some instances reference is made with some degree of precision to a specified year, but more commonly open and notorious use of water for many years is asserted in broad and vague terms. Still later the idea gained almost general acceptance that the mere act of posting a written notice of claim was the only thing necessary to secure title to water, or, at least, that it was the most important step.

It may be safely stated that few of the recorded water claims bear evidence of having been prepared by an attorney at law, but the great majority make a serious attempt at legal formality and phraseology. A favorite phrase is to the effect that the claim is made "under and by virtue of the laws of the United States and of the State of California in such cases made and provided," whereas the remainder of the document itself is abundant proof that the claimant possessed not the slightest idea what those laws were. Another clause often found is the allegation that the claimant is "a natural-born citizen of the United States over the age of twenty-one." A volume could be filled with the superfluous and wholly irrelevant statements contained in notices which omit to mention the most essential facts.

APPROPRIATIONS OF WATER.

Section 1415 of the civil code of California, enacted in 1873, provides as follows:

A person desiring to appropriate water must post a notice in writing, in a conspicuous place at the point of intended diversion, stating therein:

(1) That he claims the water there flowing to the extent of (giving number) inches measured under a four-inch pressure.¹

(2) The purpose for which he claims it, and the place of intended use.

(3) The means by which he intends to divert it, and the size of the flume, ditch, pipe, or aqueduct in which he intends to divert it.

A copy of the notice must, within ten days after it is posted, be recorded in the office of the recorder of the county in which it is posted.

The records show that as knowledge of these statutory requirements slowly spread among the people subsequent claimants endeavored, either in good faith and to the best of their ability, to comply therewith, or by perfunctory compliance with the letter of the law to evade its spirit. In consequence many absurd and preposterous claims have been perpetuated upon the record books.

The meaning of the term "to appropriate" has been generally misunderstood and continues so to this day. To a great majority of people appropriation and claiming are synonymous terms, and no language is more common in water notices than the statement that "I hereby appropriate the water," etc.

It is a matter of common knowledge that in general the posting of a notice at the place of intended diversion is farcical. Usually the posting is performed by attaching the paper to the rough bark of a convenient tree somewhere in the vicinity. Tacks or nails are not often provided, and substitutes are made of two or more twigs driven into knife punctures in the bark. Permanence of this notice is seldom deemed desirable and is less often secured. The wind may tear it from its insecure fastening a few minutes after being placed in position. If not destroyed bodily or blown away the first rain may blur or the sun may fade its writing to illegibility. But what matter? By posting the notice and recording a copy thereof within ten days the claimant has complied with the law and has no further concern. If the public or any individual suffers through the insufficiency or the ephemeral character of the notice, that is not to be regarded as the claimant's fault, but as the other man's misfortune. In very many cases, a suitable tree not being at hand, the notice is not displayed to view in a conspicuous place at all, but is folded, laid upon a boulder or on the ground and weighted down by a stone. It would require diligent search to bring to light all the notices which may be quietly reposing under stones in some of our mountain canyons.

¹ This unit of measurement is regarded as equivalent to one-fiftieth of 1 cubic foot per second.

The statute fails to require that the posted notice shall describe the geographical position of the place of intended diversion. However, probably a majority of the claims of record in Los Angeles County recognize the desirability of giving such information, and they attempt to furnish it. Unfortunately, in a vast number of cases, the description of locality is so vague and indefinite as to fail utterly in conveying any useful information. Usually the facts set forth with most particularity are those which are the most unnecessary, because perfectly obvious, viz, that the places are situated in Los Angeles County, Cal.; and in many cases no more definite description is given. Numerous statements like the following are found: "I claim the water where I now stand," or "where this notice is posted on a tree," or "in this canyon." Following are a few quotations from recorded claims, and they constitute the only information contained in the several notices as to the localities:

We, the undersigned, claim this water from this monument and ditch for 3 miles down this canyon.

This water situated about 12 miles from the city of Los Angeles.

NOTICE.—The undersigned takes up this canyon and claims all this water running through this and to run, 24 inches more or less, for agricultural and mining purposes, this notice being posted at both ends of said canyon.

At a point above where the road crosses the stream and where the channel is depressed and the banks are steep and precipitous, being about 8 feet high, the right bank being covered with rocks and the left with trees.

The water running in a north and south direction in this canyon.

This notice is posted about 3 miles down the canyon from some three arrastres run by steam power and about 400 yards above an old stamp mill on the same canyon or creek.

At this point, being a short distance above a large boulder situated in the bed of the creek.

This notice is posted on a tree just below the water in the canyon.

Many others of similar tenor are found. Frequently the only description is by reference to some obscure local name of a canyon not shown upon any map and known to a few residents of the immediate locality only.

The statute imposes no restriction upon the amount of water which may be claimed. In matters of this sort the virtue of self-denial is one seldom displayed. On the contrary the actuating principle evidently is to "Get a plenty while you're getting." Pursuing this policy it is exceptional to find a notice which does not claim all the water of the stream, whether it be large or small. Frequently all this is amplified to embrace "All that is now flowing or that may flow at any future time;" "All that is above or below the surface;" "All the water in this canyon, developed and undeveloped;" "All the water flowing or that can be made to flow;" "All the water flowing and that can be developed and diverted either by ditch, dam, well, or tunnel." One man makes this brief but forcible declaration: "I claim all the water

rights of this creek." Where the claimant complies with the code provision requiring that the number of inches claimed shall be stated, it is customary to claim a practically impossible quantity. Large numbers are almost as easily written as small ones, and there is no extra cost for recording the notice. Hence, no inducement exists for the claimant to exercise moderation in the statement of his claim. Many notices claim a specified number of inches, with the inconsistent qualification "more or less."

It is not at all surprising that a great many persons seeking to give a legal notice of their claims to water should stumble at such an incomprehensible unit of measure as the "inch," measured under a 4-inch pressure. Many of their efforts to obey the law in this respect are ludicrous. One claims "all the water, amounting to 150 inches by hydraulic pressure of 4 feet measurement." Another notice reads, "The undersigned claims 4 feet of water from under a 4-inch pressure;" another, "To the extent of 100 square inches, miner's measurement;" still another, "100,000,000 cubic feet."

The provisions of the code show clearly the intent of the legislature, that before any person seeking to appropriate water can acquire any right therein he must have formed a definite plan of action, so far perfected in detail as to enable him to set forth in his preliminary notice the more prominent features of his plan. Thus the law requires that the posted and recorded notice shall state the purpose for which water is claimed and the place of intended use; the means of diversion and the size of the proposed conduit. Some of the smaller claims attempt to do this in good faith, but it is a more popular custom to evade these requirements by the broadest generalities. This is especially noticeable in the larger claims, which are generally for speculative purposes. It is common to find notices claiming for all possible purposes which the ingenuity of the claimant can devise, and specifying nearly the whole of southern California as the place of intended use; that the diversion is to be accomplished by means of "headworks" and the water is to be conveyed by "conduits of sufficient size to carry the said amount." Sometimes the latter clause is expanded to include every form of conduit known to the claimant, for example: "By tunnels, cuts, earthen ditches; canals lined with masonry, concrete, stone, brick or other materials; flumes of wood or metal; pipes of wood, steel, iron, cement, vitrified clay, or other substances; all to be of sufficient size for the purpose," or "of such size as a competent hydraulic engineer may recommend."

Although the claimants are usually most liberal to themselves, wording their claims in phrases broad enough to cover all future contingencies, instances are numerous in which the notice shows that its author had no adequate conception of the quantity of water claimed or the carrying capacity of the specified conduit. One proposes to

divert 200 inches by means of "an iron pipe 2 inches in diameter for the first 40 feet, thence 1 inch to the place of intended use" (a considerable distance away). Another claims "3,000 inches of water under a 4-inch pressure in this canyon and its branches, to be taken out in pipe 1½ inches in diameter." The performance of this feat would require the water to pass through the 1½-inch pipe at the rate of almost 1 mile a second, or about three times the velocity of a rifle bullet. Another claims 3,000 inches "to be taken out in a ditch 15 inches wide and 10 inches deep." It would be interesting to know how long the ditch endured the wear of such a destructive velocity as would be required. One prudent and farsighted man, after claiming a liberal flow of water and describing the ordinary means of diverting the same, provides for the emergencies of future dry years by adding, "I also claim the right to hand or pack from here to said ranch in case of drought or too little to run down."

From one cause or another the great mass of recorded notices wholly fail to perform the duty they were designed to fulfill. Probably the majority possess, or at one time have possessed, some value to the claimant, but they usually fail to give such notice to the public as the latter is entitled to expect when public property is sought to be taken for private use. If the claimant proceeds diligently and uninterruptedly with the construction of his works and actually appropriates the water as claimed in his notice, he is entitled to have the right thereby acquired date back to the time of posting the said notice. In this event it may be important, although by no means indispensable, to have an official record of the fact. Unfortunately it is the exception rather than the rule that a claim is ripened into an appropriation, according to the terms of the notice or in the manner and within the time specified by law. In all such cases the recorded notice of claim is false and misleading, and with the lapse of time may acquire a force and standing to which it is in no wise entitled.

In California there is no officer authorized to scrutinize in any manner any water claim offered for record, nor whose duty it is to see whether the rights claimed by such notice are actually secured by the subsequent actions of the claimant, or whether they are allowed to expire by reason of his default. Vital questions touching prior rights to the water—the validity of the new claimant's preliminary notice, the good faith of his late proceedings, the question as to whether an appropriation for a beneficial use has been made and, if so, the amount of this appropriation—are one and all left to be determined by litigation. Under our present law, or lack of law, on this point there is no other manner in which these questions can be decided. It is a matter of common knowledge in this portion of the State that a lawsuit over water rights is the most protracted and costly form of litigation with which our courts are congested. * * *

**EXTRACT FROM REPORT ON PROBLEMS OF WATER STORAGE ON
TORRENTIAL STREAMS OF SOUTHERN CALIFORNIA, AS TYPI-
FIED BY SWEETWATER AND SAN JACINTO RIVERS.**

By JAMES D. SCHUYLER, C. E.,

Consulting Engineer, Los Angeles, Cal.

INTRODUCTION.

Sweetwater and San Jacinto rivers have been selected for the study of water-right conditions and general storage and irrigation problems because on each of these streams substantial masonry dams have been erected and the storage of water and its distribution for irrigation and general domestic service have been established for a period sufficiently long to afford valuable experience and precedents. The writer has been selected to make a study and presentation of these problems and experiences, presumably because he was the engineer who designed and built the dams on both streams.

Aside from the Bear Valley dam on the head waters of Santa Ana River and the Cuyamaca dam on the head waters of San Diego River, the Sweetwater and Hemet dams are the only completed structures in southern California that impound, utilize, divert, and distribute water from torrential streams. A number of other dams have been projected and several have been partially or wholly completed, but are not as yet in service.

There is a peculiar interest attached to the storage reservoir and distributing system which derives its supply from a torrential stream, as it is a creation of something of permanent value out of that which would not only be otherwise wasted and lost, but would frequently cause havoc and destruction to property in the act of going to waste. As its name implies, the torrential stream is one of violent force and action during certain intermittent periods of its career, and its power and capacity for destruction everywhere need to be curbed. Not the least useful of the functions of the impounding reservoir, therefore, is that of lessening the destructive force of the torrent upon which it is situated. It is doubtful, however, if such substantial and costly works as are needed for effecting this purpose would be undertaken by any community for that object alone, and unless the water impounded can be put to use, and either harnessed for power or consumed in irrigation, or both, and is obtainable free from legal complications or harassing restrictions, the incentive will always be lacking for the construction of such permanent dams either by individuals, private corporations, or municipalities. Every possible encouragement needs to be afforded for such enterprises in the way of smoothing the legal paths, and the purpose of this inquiry, as I understand it, is to ascertain what the experience of years in the actual impounding and use of

water on these streams has been, physically and legally, and what modifications of the laws appear to be desirable in the light of these experiences in order that it may become easier to utilize the public streams and the water going to waste. The obstacles which nature places in the way of executing such works are quite sufficient without having to overcome legal barriers and restrictions of a burdensome nature. These natural obstacles are such as to restrict the number of enterprises which are practical from an engineering standpoint to a very few, and consist chiefly in a lack of a satisfactory combination of conditions essential to success. These requisite conditions are, briefly stated:

First. A dam site, preferably in a narrow gorge, whose foundations are suitable for the erection of any height of dam required, of any type that may be selected.

Second. A capacious valley above the dam site, with little fall or grade, and affording a reservoir site of capacity commensurate with the size of the stream, with a reasonable height of dam.

Third. An area of arable lands and a resident population requiring water sufficiently extensive to consume all that may be stored in the reservoir and capable of producing crops of a character and value which will admit of the payment of water rates demanded, these lands being below the elevation of the dam, in its near vicinity, and readily commanded by the stored water through gravity conduits.

Fourth. A watershed above the reservoir of sufficient area to afford adequate run-off from the normal rainfall to fill the reservoir periodically with certainty.

Fifth. A fairly reliable average rainfall.

It will be seen at a glance, with a moment's reflection, that the conjunction of all these conditions, each of a favorable nature, must necessarily be rare. The great majority of the mountain gulches, canyons, and torrents, though abounding in dam sites, have no reservoir sites, except perhaps so near the crest of the mountains as to afford but limited water supply to them.

For these reasons it becomes all the more essential that there be no friction between such enterprises as are feasible and the laws of the land which control them. * * *

THE DUTY OF THE SWEETWATER RIVER.

One of the most interesting problems in connection with the utilization of every stream is the determination of the probable maximum duty to be expected from that stream when its waters shall have been conserved to the fullest extent practicable. The solution of this problem should be the work of the United States Government, for it is one of national importance and too large for any lesser organization to attempt. If it be determined within reasonable limits of accuracy in

advance of the construction of storage works, much ill-advised investment of capital can be saved and the development of the water supply may be made with a greater certainty as to the results to be achieved. A stream which may have been generally regarded as a reliable supply for irrigating 50,000 acres, for example, might prove, on thorough investigation, to be good for only 10,000 acres. If the discovery of its real duty is made before the distributing system is built over an extravagantly large area and before water is pledged to more lands than can possibly be supplied, much complication will be avoided, and much unnecessary waste of money saved. For lack of this sort of information, which it is the function of the Government to gather and tabulate for general use, many ill-advised schemes have been projected throughout the United States, and more are being projected every year which would be condemned, wholly or in part, if their true value were outlined by such preliminary studies. For this reason the experience of the Sweetwater system is of value as a precedent.

The supply of water required in irrigation on the system has been assumed to be about 1 acre-foot per acre per annum, or what is equivalent to 12 inches of rainfall, and this is the volume apportioned by the company as the annual allowance granted in their water-right contracts. The actual use, including the consumption for domestic supply to the inhabitants of National City and Chula Vista, has averaged about 1.5 acre-feet per acre. A rough check on this estimate, which has been arrived at from independent observation and data, is obtained in the following manner: The total run-off in thirteen years was 180,070 acre-feet, all of which was used in twelve years; the total amount passing over the top of the dam as waste during this period was, approximately, 80,070 acre-feet, leaving for utilization and to supply evaporation, 100,000 acre-feet. This 100,000 acre-feet was equivalent to a mean of 8,333 acre-feet per annum over the twelve-year period. Taking this volume as the assumed mean contents of the dam, the mean area of surface exposed to evaporation was 436 acres. As the evaporation loss was measured for several years its mean was ascertained to be about 4.5 feet in depth per annum, and this depth in twelve years would have amounted to 23,544 acre-feet, or 23.5 per cent of the total salvage from the flow of the stream. The remaining 76,454 acre-feet would represent the volume actually consumed in irrigation, after deducting domestic service and leakages.

As a check upon this computation of the total loss by evaporation I have taken the weekly record of gage heights kept without interruption from April 30, 1888, till January 1, 1898, kindly furnished by Mr. Savage, and from the table of areas and contents of the reservoir at different levels I have placed opposite each weekly gage reading the corresponding area of reservoir surface exposed to evaporation. The sum of these areas divided by the number taken each year gives the

yearly mean area of surface exposure. From this data I have made the following interesting table:

Reservoir surface exposed to evaporation, 1888-1897.

| Year. | Maxi- mum. | Mini- mum. | Mean. | Remarks. |
|---------------|---------------|---------------|---------------|---|
| | <i>Acres.</i> | <i>Acres.</i> | <i>Acres.</i> | |
| 1888 | 424 | 342 | 372 | After April 30. Emptied by order of court. |
| 1889 | 713 | 110 | 500 | |
| 1890 | 183 | 102 | 140 | |
| 1891 | 642 | 145 | 503 | |
| 1892 | 607 | 446 | 511 | |
| 1893 | 711 | 443 | 583 | Dam overtopped by flood. |
| 1894 | 549 | 331 | 448 | |
| 1895 | 829 | 333 | 600 | |
| 1896 | 469 | 224 | 338 | |
| 1897 | 458 | 206 | 316 | |
| Average | | | 431 | |

This figure of mean surface exposure closely corresponds with that derived by a totally distinct method and affords a gratifying check upon the computation, although a more accurate and more laborious process of reaching the result would be to multiply the measured evaporation each week by the area corresponding and sum up the total instead of taking a mean evaporation loss for a period of years.

Assuming an average consumption of 50 gallons per capita in supplying domestic demand, and estimating the population as 2,500 inhabitants, the volume thus represented would be equivalent to 1,600 acre-feet in twelve years. This quantity being deducted from 76,454 and the remainder divided by 12, the quotient is 6,230 acre-feet, as the average volume of water applied to the lands annually during the twelve years. The area irrigated in 1896 reached a maximum of 4,580 acres. If a mean area of 4,000 acres be assumed as having been irrigated, the mean depth of water applied, by the above computation, would be 1.56 feet. This is of course a very rough approximation of the probable consumption during the period in question. It is closely corroborated by numerous meter measurements of the volume applied to certain unknown areas, so that the actual use may be fairly closely stated to have been 1.5 feet in depth per annum.

There has been a growing conviction, however, that the orchards would have thrived equally well, and perhaps better, with a more moderate application of water. The experience gained in the care of bearing orchards since the great drought compelled the company to seek and develop an independent source of supply has shown that the trees will live and bear with an extremely small allowance of water. The history of the use of water in 1899 is extremely interesting. At the beginning of the irrigation season the reservoir contained barely 40,000,000 gallons of water. By the sinking of numerous wells in the upper part of the reservoir valley and in the valley below the dam, and by the establishment of elaborate pumping plants, the company developed and pumped 457,000,000 gallons, of which they estimated 104,000,000 gallons were used in supplying domestic service and for

mechanical purposes, leaving 317,000,000 gallons as the amount of pumped water used in irrigating 3,800 acres of orchard, chiefly citrus fruits. This, added to the 40,000,000 gallons in the reservoir, gave a total volume of supply of 1,096 acre-feet. Thus the average depth of water applied was but 0.288 foot, or 3.375 inches. The irrigation was supplemented by thorough cultivation, and the orchards, when thus cared for, were quite thrifty and bore heavily. In fact, the lemon crop was never so heavy as the one following the drought of 1899. The water used was but 18.5 per cent of the average amount previously applied. Still it can not be argued from this experience that such extreme economy could be practiced as a regular thing. It appears to be the general opinion now among the irrigators that they have heretofore used more water than necessary, and that the allotment of 1 acre-foot per annum (326,000 gallons per acre, or 12 inches in depth) is ample for their orchards and all other crops, except alfalfa, which requires rather more. This being accepted as a reasonable allowance, the maximum possible duty of Sweetwater River in irrigation, based on the measured run off of thirteen years, may be deduced as follows, assuming that ample storage capacity be provided: The average annual run off is 13,492 acre-feet, of which the loss by evaporation from the surface of reservoirs may be 25 per cent. This would leave 10,119 acre-feet as the average volume available for actual irrigation, which would irrigate 10,119 acres.

In short, had there been more reservoirs on the Sweetwater having a combined storage capacity of 75,000 acre-feet (instead of 18,000 before the flow of 1895, and 22,500 since the following year) the stream flow since 1887 would have amply irrigated about 10,000 acres of land, chiefly in orchard, without the panicky conditions resulting from successive droughts; but with conditions as existing to-day having a reservoir of but 22,500 acre-feet capacity, the safe duty of the stream is probably less than 3,000 acres without having to resort to pumping an auxiliary supply during dry seasons.

To provide for the contingencies of drought and losses by evaporation in streams of this class, judging solely from the record of thirteen years, it would appear to be essential to provide 7.5 acre-feet of storage capacity for each acre desired to be irrigated. Having such storage provided, the area which may be irrigated from the catchment of a given watershed is approximately one-twelfth of the area of the watershed. These deductions may be modified with further experience, and would only apply to similar conditions of soil, climate, and character of run-off.

Sweetwater River is essentially a stream for storage utilization only. It has practically no living water except at its extreme sources and for 10 or 20 miles down from the summit of the range. From June to the following November or December there is rarely any flow into the Sweetwater reservoir. For this reason there have been practically no attempts to utilize the normal summer flow for irrigations except in a very small way.

